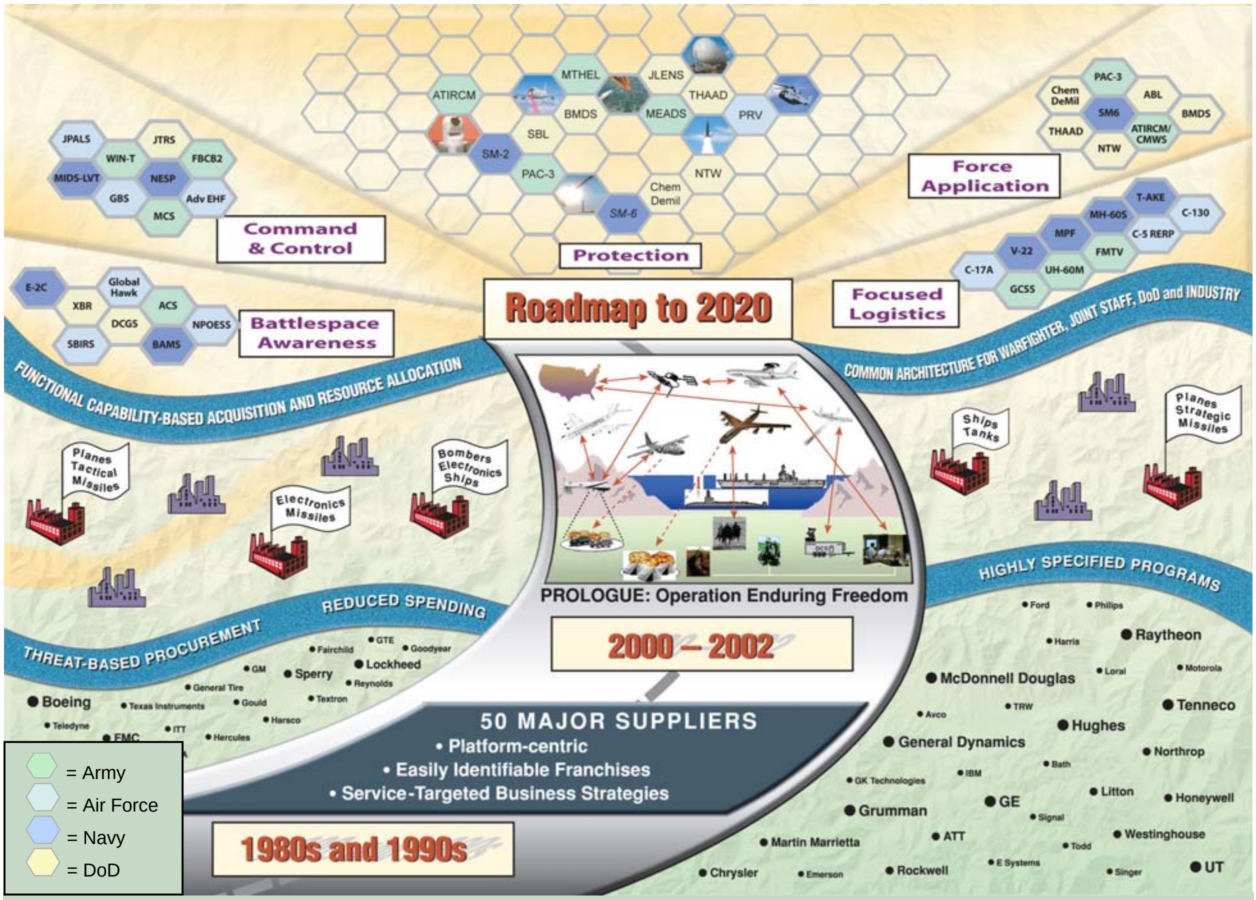


DEFENSE INDUSTRIAL BASE CAPABILITIES STUDY: PROTECTION

DECEMBER 2004

Report Documentation Page

Form Approved
OMB No. 0704-0188

Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.

1. REPORT DATE **DEC 2004**	2. REPORT TYPE	3. DATES COVERED **-**
4. TITLE AND SUBTITLE **Defense Industrial Base Capabilities Study: Protection**		5a. CONTRACT NUMBER
		5b. GRANT NUMBER
		5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)		5d. PROJECT NUMBER
		5e. TASK NUMBER
		5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **ODUSD (Industrial Policy),241 18th St South,Arlington,VA,22202**		8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)		10. SPONSOR/MONITOR'S ACRONYM(S)
		11. SPONSOR/MONITOR'S REPORT NUMBER(S)
12. DISTRIBUTION/AVAILABILITY STATEMENT **Approved for public release; distribution unlimited**		
13. SUPPLEMENTARY NOTES **The original document contains color images.**		
14. ABSTRACT **see report**		
15. SUBJECT TERMS		

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**		**196**	

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

A version of the cover graphic was used in *Transforming the Defense Industrial Base: A Roadmap* (ODUSD (IP), February 2003). This earlier study concluded that the Secretary's transformation mandate required a different lens for viewing the defense enterprise—one organized around the most essential operational effects that the U.S. warfighter must be able to deliver to be successful. The Joint Staff has now reorganized around new functional concepts. The top of the landscape shows the joint functional concepts where materiel solutions play a major role: Battlespace Awareness, Command and Control, Force Application, Protection, and Focused Logistics, with representative programs indicated for each. The Department is also developing other functional concepts such as Network Centric Operations. These functional concepts, along with related joint operating and integrating concepts, are becoming the central theme for Department decision-making. ODUSD (IP) will continue to adjust its industrial base capability assessments to reflect evolving DoD concepts as appropriate.

This move to capabilities-based decision-making will fundamentally change the defense enterprise. How the Department looks at what it has and what it needs also will affect who participates in the defense industrial base—and likely will cause it to expand. Capabilities-based decision-making provides a common and comprehensive vernacular to the operators, the acquirers, and industry. Clearer communication and an integrated vision should continue to improve the efficiency of planning, decision-making, and execution.

This report and all appendices can be viewed online and downloaded at:

http://www.acq.osd.mil/ip

This report was produced for the Under Secretary of Defense (Acquisition, Technology, & Logistics) by the Deputy Under Secretary of Defense (Industrial Policy) from April - December 2004. Robert Read led this effort; Dawn Vehmeier, Michael Caccuitto, Gary Powell, and Dawana Branch also had major roles in the production of this report. Support was provided by Booz Allen Hamilton, Inc. (BAH), the Institute for Defense Analyses (IDA), and First Equity Development, Inc. Among others, special thanks are due to John Williams and Carmen Alatorre-Martin of BAH, and Jim Woolsey and Emile Ettedgui of IDA for their important contributions. The team would like to acknowledge the contributions of the Study's Red Teams, consisting of 26 individuals, who reviewed this report. Companies listed or mentioned in this report are representative and not exhaustive. Inclusion or exclusion in the report does not imply future business opportunities with, or endorsement by, the Department.

Inquiries regarding the report should be directed to Mr. Robert Read at (703) 697-0051 or (703) 602-4287. Certain suppliers of which the authors were not aware may possess technologies that mitigate identified industrial base insufficiencies. Such suppliers should contact Mr. Read to document those capabilities for future use. Appendix G provides a form with which such technologies can be brought to the attention of this office.

DEFENSE INDUSTRIAL BASE CAPABILITIES STUDY: PROTECTION

OFFICE OF THE DEPUTY UNDER SECRETARY OF DEFENSE
(INDUSTRIAL POLICY)

DECEMBER 2004

Defense Industrial Base Capabilities Study (DIBCS) Series Study Objectives
Develop a capabilities-based industrial framework and analytical methodology as a foundation for programmatic and investment decision-making.
Identify technology critical to enabling the new Joint Staff functional warfighting capabilities. Establish a reference database of key industrial base capabilities mapped to warfighting functional capabilities.
Conduct industrial base capability assessments on priority critical technologies to identify deficiencies.
Develop a systematic methodology to craft industrial base strategies to remedy industrial base deficiencies identified; and encourage proactive, innovative management of the industrial base.

TABLE OF CONTENTS

Findings

Defense industrial base assessments must be done in a context which links warfighting and industrial base capabilities. This report deploys a methodology to do this.

Specifically, this study focuses on the Protection functional concept as defined in the Joint Staff's Protection Joint Functional Concept (PJFC). At its core, the goal of Protection is to defend personnel (combatant and non-combatant), physical assets, and information of the United States, its allies, and friends. This includes protection against explosive, chemical, biological, nuclear, radiological, air, missile, and cyber attack. As the Department transforms, the importance of Protection continues to grow as exemplified by the need to develop flexible improvised explosive device (IED) jammers, protection against rocket propelled grenades (RPGs), and futuristic combat suits to protect warfighters from chemical/biological attacks. Indeed, *DIBCS: Protection* highlighted the importance of warfighting capabilities and technologies associated with jamming IEDs and anti-RPGs. In spite of high priority efforts to provide effective near-term active protective measures against these threats, specific technological solutions still are being developed or adapted. Hence, while these warfighting capabilities are necessary to meet the PJFC, industrial base sufficiency can be assessed only relative to a defined technological solution. Therefore, this report identifies those warfighting capabilities for which technologies still are being developed where the industrial base may need attention once the technologies begin emerging.

In the broadest sense, Protection warfighting capabilities include the ability to detect and assess threats, provide warning, defend (both actively and passively), and manage consequences (recover). Using the PJFC, the Defense Industrial Base Capabilities Study (DIBCS) methodology identified 629 capabilities that directly enable American warfighting leadership in this area. To enable these capabilities, 277 technologies qualified as ones in which the United States should lead any potential adversary. Of these 277 technologies, the study team assessed industrial base sufficiency for 39 priority critical technologies and 25 associated components.

ODUSD (IP) found:

- With few exceptions, available industrial base capabilities for these technologies are sufficiently innovative and robust. The study team developed remedial strategies for seven technologies where sufficiency can be assured only with active implementation of policy measures. Also during the course of this study, the DIBCS methodology identified unusual technology solutions that are not likely to be part of the U.S. warfighting arsenal, but could pose challenges to U.S. warfighters if possessed by potential adversaries. These technologies supplement the ongoing "Watch List," created in *Defense Industrial Base Capabilities Study: Force Application* (*DIBCS FA).* "Watch List" items merit further consideration and potential policy remedies. Additional technologies with similar impacts may surface in future assessments and will be added to this "Watch List."

- Production-ready technologies have limited on-ramps to ongoing programs. ODUSD (IP) first treated these transitional issues in case studies of 24 emerging defense suppliers in late 2002. The study team re-visited a number of these companies and realized that such innovations can be sidelined as a result of many factors: program managers' budgetary constraints; technologies not envisioned in original program requirements; kernels of innovation embedded in losing contract bids; or other technologies not completely aligned with current requirements, like those on the "Watch List." The concept of an Industrial Base Investment Fund (IBIF) has evolved from the previous Innovation Clearinghouse. An envisioned IBIF would be a Congressionally-funded instrument managed at the most senior acquisition level of the Department, designed to insert producible technologies into programs of record.

- DIBCS assessments already are informing DoD policies and processes related to acquisition strategies, and anti-trust and national security evaluations of proposed business combinations.

Recommendations

1) The Department should implement the remedies in this report to address the seven industrial base issues identified in the Protection area, and should continue to monitor the two "Watch List" items.

   - The seven industrial base issues needing additional attention are:
     - Non-lethal Millimeter Wave Active Denial System;
     - 30-mm Supercavitating-Supersonic Projectiles;
     - Multi-Spectral Camouflage Cover;
     - Regenerative Chemical-Biological Filtration;
     - Plasma Antenna;
     - Active Magnetic Signature Reduction System;
     - Thermo-Insulating Paint for Low Observable Hullforms.
   - The "Watch List" items are:
     - Towed Fabric Balloon Pressure Sweep;
     - Rigid Polyurethane Foam (RPF).

2) The Department should establish an Industrial Base Investment Fund to provide better on-ramps for production-ready technologies. These technologies would be nominated by emerging innovative suppliers or company/Department program managers, and implemented via Capability Area Reviews.

3) Within the Department, ODUSD (IP) should continue to provide policy guidance and oversight for DoD efforts to strengthen the industrial base and serve as the clearinghouse for these efforts. ODUSD (IP) will assess Focused Logistics industrial base sufficiency using the capabilities framework, databases, and policy tools of the DIBCS process; and also identify emerging priority critical technologies against which industrial base sufficiency cannot yet be assessed. ODUSD (IP) then will consolidate, re-evaluate, and update all DIBCS series findings and recommendations; and research and assess other technologies of interest.

FOREWORD

This defense industrial base capability study on the Protection Joint Functional Concept is the fourth of a five-part series initiated in January 2004, and scheduled to be completed in mid-2005 with the publication of *Defense Industrial Base Capabilities Study: Focused Logistics.* This study series is but one of several efforts underway in the Department to assure the capability of the industrial base to supply warfighters now and well into the future.

> *"If the Department is often accused of preparing to fight the last war, the purpose of the DIBCS series is to assure that the industrial base available to the Department in the 2015-2020 timeframe can produce the warfighting capabilities required then. In this way, the DIBCS series complements the Department's day-to-day activities that ensure the current defense industrial base can meet contingency and near-term warfighting requirements."*
>
> *Suzanne D. Patrick,*
> *Deputy Under Secretary of Defense*
> *(Industrial Policy)*
> *CSIS Conference, December 8, 2004*

During the global war on terrorism, the Department has used the powers of the Defense Priorities and Allocations System (DPAS) to require preferential performance on the nation's production lines to better serve the warfighter. Examples of this include expediting delivery of multi-spectral targeting systems for Predator unmanned aerial vehicles by 18 months and providing satellite communication radios to United Kingdom (U.K.) forces operating in Afghanistan four months prior to their originally scheduled delivery. Where production capacity or conflicting service requirements are at issue, the Priority Allocation of Industrial Resources (PAIR) Task Force, chaired by the Office of the Deputy Under Secretary of Defense for Industrial Policy (ODUSD (IP)) has stepped in to prioritize and allocate deliveries to the most critical defense applications. It was the PAIR Task Force that allocated among the Services the ballistic backing material used in body armor such that all U.S. forces in Iraq had body armor by January 2004. The PAIR Task Force continues to manage the allocation of body armor material and is the forum that would be used to manage other issues of industrial base insufficiency or conflicting demands among the military services. The Department also has instituted a process to protect critical defense industrial infrastructure in agreements being crafted between these facilities and the Defense Contract Management Agency (DCMA) under the overall direction of the Assistant Secretary of Defense (Homeland Defense).

To meet its ongoing responsibilities, the Deputy Under Secretary of Defense (IP) and Director, DCMA, signed an agreement in December 2001 to maintain a database which reports on industrial base sufficiency for over 500 companies currently doing business with the Department. Industrial base sufficiency is assessed based on factors such as facility capacity as compared to demand, industrial or technology capabilities, and manufacturing lead time.

The DoD acquisition strategies and buying patterns affect the Department's ability to meet its future mission requirements. In response, ODUSD (IP) has conducted industrial base assessments over the last several years on issues as varied as the fixed wing, vertical lift, and unmanned aerial vehicle industrial bases; foreign content in U.S. weapons systems; and strategic materials such as beryllium. It is under this broad responsibility that ODUSD (IP)'s current Global Shipbuilding Industrial Base Benchmarking Study is underway.

Finally, the Department continuously monitors and addresses any adverse impacts of its acquisition decisions in the industrial base. In fact, the Department understands that the industry supporting defense is reshaping itself to respond to significant changes in military missions. Major defense firms are responding by reducing excess capacity, streamlining processes, and revamping supplier relationships. These changes may have negative impacts on certain suppliers within the United States. The Department has developed policies, processes, and structured procedures necessary to make appropriate judgments about identified industrial issues and to integrate those judgments into its regular budget, acquisition, and logistics processes. DoD Directive 5000.60, "Defense Industrial Capabilities Assessments," and the accompanying Handbook 5000.60-H, "Assessing Defense Industrial Capabilities," established the policies, procedures, and circumstances under which the Department will take action to preserve endangered industrial capabilities. Basically, before taking action, the Department must verify the warfighting utility of the industrial capability, that the industrial capability is unique and at risk, that there are no acceptable alternatives, and that the proposed action is the most cost- and mission-effective.

> *"This Directive establishes policy and assigns responsibilities for assessing defense industrial capabilities. The purpose of the assessment is to ensure that the industrial capabilities needed to meet current and future national security requirements are available and affordable."*
>
> *DoD Directive 5000.60*
> *Defense Industrial Capabilities Assessments*
> *April 1996*

Among the myriad ways in which the Department seeks to assure the technological superiority of its warfighters, the DIBCS series is intended to assess and assure industrial base sufficiency to produce warfighting capabilities well into the future.

Combat operations in Iraq have made painfully clear the importance of the Protection functional capability. Senior officers who participated as Red Team members in the review of this study pointed out that certain problematic combat capabilities, not assessed as industrial base sufficiency issues, are required to deal with the evolving threat during nation-building operations in an urban environment. In the cases of chemical-biological protective suits and body armor for soldiers, industrial base assessments showed that while equipment deliveries may not progress as quickly as required, the technological solutions are available and production capacity is increasing. In the cases of improvised explosive devices (IEDs) and rocket propelled grenades (RPGs), technological solutions that provide effective near-term active protective measures against these specific threats have not yet been developed or adapted.

Absent a technological solution, industrial base sufficiency cannot yet be assessed—but will be once technological solutions emerge. Clearly in some cases, such as ballistic armor for tactical vehicles in war zones, the Department did not recognize the problem early enough to ensure adequate supply. In all cases—including where it developed non-materiel, tactical, or operational solutions to counter a threat—the Department has worked hard to protect its warfighters.

> ***A Note on Industrial Base Sufficiency***
>
> *The Department assesses industrial base sufficiency based primarily on two factors: (1) an adequate number of sources (particularly in cases of high demand and/or multiple applications) and (2) suppliers with sufficient innovation to maintain U.S. technological lead over likely adversaries. The DIBCS methodology does not highlight as issues those situations involving short term capacity shortfalls or cases requiring the development of technological solutions. Two examples follow.*
>
> *DIBCS: Protection does not highlight as industrial base sufficiency issues the production difficulties of surging chemical biological protection suits and body armor for troops deploying to Iraq. In these cases, deliveries did not occur as quickly as desired. However, the Department has taken steps to increase production capacity.*
>
> *DIBCS: Protection also does not highlight as industrial base sufficiency issues the difficulties associated with overcoming certain threats that emerged from the Iraqi conflict, such as IEDs and RPGs. Technological solutions that provide effective near-term active protective measures against these specific threats have not yet been developed or adapted. Absent a technological solution, industrial base sufficiency cannot yet be assessed.*

One of the most important lessons learned from an industrial base perspective is the importance of anticipation, early recognition, and stable funding of innovative solutions to warfighting requirements in peacetime and during combat operations. Some of the industrial base issues identified in this study may appear esoteric against the stark relief of current combat operations. For instance, regenerative chemical-biological filtration and non-lethal millimeter wave active denial systems are of limited utility in urban combat fought in close quarters and short distances. However, for a future war involving a chemical-biological operational environment or the requirement to protect American and allied forces in open spaces against significant numbers of less well armed forces (potentially intermingled with non-combatants), these systems will be just as critical as ballistic armor is today.

Another lesson learned from current combat operations relative to the Protection functional concept is the importance of "Consequence Management"—some of which is enabled by operational tactics and not just materiel solutions. Among the materiel solutions to "Consequence Management" challenges, however, many are from the commercial industrial base—a reminder of the importance of a contracting and acquisition culture that embraces the speed and efficiency available in the commercial marketplace.

RED TEAMS

Government Warfighting Capabilities Members

RADM Michael G. Mathis, Director, Joint Theatre Air & Missle Defense Office (JTAMDO)
Dr. Kent Stansberry, Deputy Director, Missile Warfare, Defense Systems, OSD
BGen Keith McNamara, Director, Force Structure Integration & Deployment, Missile Defense Agency
BGen James R. Moran, Program Executive Officer, Soldier
Mr. Rick Decker, Deputy Joint Program Executive Officer for Chemical-Biological Defense
Mr. Michael Novak, Associate Director, Joint Force Application, Defense Systems, OSD
Mr. Dave Weddel, Deputy FORCENet, C4, Chief of Naval Operations for Warfare Requirements & Programs
Mr. Joel Shugars, Senior Operations Analyst, Center for Special Operations, USSOCOM

Government Policy Members

Ms. Sue Payton, Deputy Under Secretary of Defense (Advanced Systems & Concepts)
Mr. Vince DeCain, Deputy Under Secretary of Defense (International Technology Security)
Mr. Terry Pudas, Deputy Director, Force Transformation, OSD
Mr. Tom Ramos, Associate Division Leader, Proliferation Detection Division, Lawrence Livermore National Laboratory

Financial Services/Venture Capital Members

Mr. Skip Grow, Managing Director, SG Cowen
Mr. Hossein Amir-Aslani, Managing Director, J.P. Morgan Securities, Inc.
Mr. Louis Bremer, Associate, J.P. Morgan Securities, Inc.

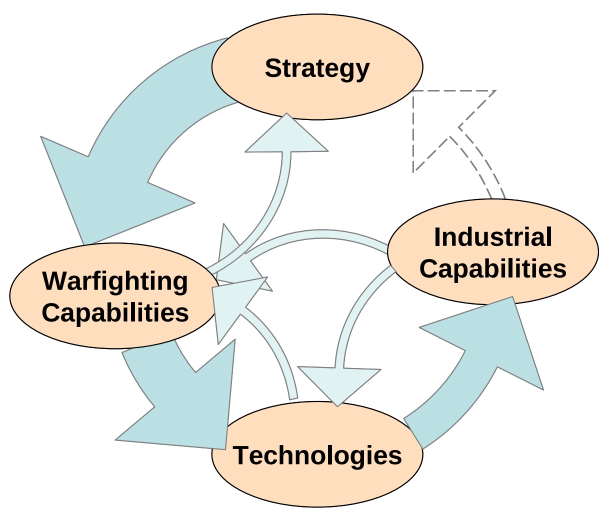
Industry Members

Mr. Colin J. Cumming, President & Chief Executive Officer, Nomadics, Inc.
Ms. Helen Greiner, Co-founder & Chairman of the Board, iRobot Corporation
Mr. Reese DeLorey, Vice President and Managing Director, Missile Defense Programs, Lockheed Martin Corporation
Mr. Tom Fitzpatrick, Vice President & General Manager, Electronic Warfare/Electronic Protection, BAE Systems
Mr. Rick Read, Senior Manager, CBRN Programs, Lockheed Martin Corporation
Mr. Shekar Rao, Senior Manager, Advanced Technology, Raytheon Corporation

Executive Summary

Early in 2003, new revolutionary requirements and acquisition process changes began germinating in the U.S. Defense Department. The processes aimed to develop and field 21st century American warfighting capabilities based on functional capabilities, not specific platforms or missions. In February 2003, the Office of the Deputy Under Secretary of Defense for Industrial Policy, ODUSD (IP), produced *Transforming the Defense Industrial Base: A Roadmap*. This report identified the need for systematic evaluation of the ability of the defense industrial base to develop and provide functional, operational effects-based warfighting capabilities. The Defense Industrial Base Capabilities Study (DIBCS) series is a systematic assessment of critical technologies needed to meet warfighter capabilities, as framed by the Joint Staff's functional concepts. In addition, the DIBCS series provides the basis for strengthening the industrial base required for 21st century warfighting needs. This report addresses the fourth of those functional concepts, Protection. Protection is the ability to defend personnel (combatant and non-combatant), physical assets, and information of the United States, allies, and friends from explosive, chemical, biological, nuclear, radiological, air, missile, and cyber attacks.

CAPABILITIES-BASED INFLUENCE CYCLE



The purpose of this process is to explicitly influence the strategy formulation of the Department, recognizing that the formulation of these inputs can be done most completely once all five DIBCS assessments are completed. This tie-in to strategy is also contingent on the synchronization of Department process changes to this new functional capabilities construct.

Source: ODUSD (IP) and Booz Allen Hamilton

The DIBCS methodology associates enabling technologies with warfighter capabilities and assesses the industrial base's ability to develop and produce those technologies. It defines national leadership goals for warfighter capabilities (*Neutral, Equal, Be Ahead, Be Way Ahead*) that establish the degree of innovation desired in the industrial base. A warfighting capability that is ubiquitous—mature and available to all countries—typically has a *Neutral* capability leadership goal. Technologies linked to *Neutral* warfighting capabilities require minimal innovation and can be sourced from the global marketplace. In contrast, a warfighting capability that brings key U.S. advantages has a *Be Way Ahead (BWA)* capability leadership goal. Technologies associated with *BWA* warfighting capabilities must lead by multiple technology generations, must be highly innovative, and often require effective competition among multiple suppliers. The graphic above shows the relationship between the Joint Staff's capabilities-based strategy and the industrial capabilities the DIBCS methodology assesses.

The DIBCS series focuses on *critical* technologies—those linked to *Be Ahead* (*BA*) and *BWA* warfighter capabilities—and then proactively assesses industrial base sufficiency for a prioritized subset of the critical technologies.

Finally, the DIBCS series recognizes that managing priority critical technologies and the associated industrial base capabilities may require policy and process changes. As such, the DIBCS series serves as a vehicle to identify, and monitor the implementation of, policy and process changes necessary to strengthen the industrial base available to the Department.

As part of the challenge of attracting new innovative suppliers to the defense industrial base, ODUSD (IP) also has begun developing a concept for an Industrial Base Investment Fund (IBIF) to address the imperfections of the on-ramps available to companies that have leading-edge, producible technologies relevant to programs of record. Program managers are intently focused on cost, schedule, and performance, and therefore may resist inserting innovative products that could impact program execution. As a result, such technologies often remain underutilized. There are other reasons technologies remain on the sidelines. For example, they:

- Do not meet programs managers' funding priorities;
- Are not in the program's scope as originally envisioned;
- Are "cutting room floor" technologies from losing bids difficult to assimilate in programs due to intellectual property or acquisition regulation restrictions; or
- Are not completely aligned with current requirements (like those on our "Watch List").

The envisioned IBIF, upon initiation, would function as a Chairman's Innovation Fund[1] managed by the Under Secretary of Defense (AT&L) as the Defense Acquisition Executive. It would aim to fund producible multi-application innovation in programs of record. Initial funding could be secured in the FY07 budget.

THE ROLE OF PROTECTION

This study begins with understanding the Protection functional concept. At its core, the goal of Protection is to defend personnel (combatant and non-combatant), physical assets, and information of the United States, allies, and friends from explosive, chemical, biological, nuclear, radiological, air, missile, and cyber attacks. The warfighting capabilities needed to achieve this goal are the capabilities of detecting and assessing threats, providing warning, defending (both actively and passively), and managing consequences (recover). Because warfighting capabilities to detect threats are most closely associated with sensors, they were addressed in *DIBCS BA*. Likewise, *DIBCS C2* addressed warfighting capabilities associated with assessing the threats and

[1] Many firms have vehicles such as a Chairman's Innovation Fund to promulgate high-value technologies developed within the corporate entity across a broad array of business opportunities.

providing the necessary warnings. *DIBCS: Protection* concentrates on the warfighting capabilities associated with defending against attacks and managing consequences.

Where possible, the DIBCS series treats individual priority critical technologies as comprehensively as possible in a single study report. However, there are some technology overlaps among reports. For example, both the Force Application (FA) and Protection reports address propulsion and structures technologies. Weapons technologies also are found in both FA and Protection (in large measure because missile defense is part of Protection). Additionally, the study team made a conscious decision to include certain technologies in Protection because of the purpose of those technologies. For instance, *DIBCS: Protection* includes protective coating technologies for FA assets because the purpose of these technologies is to *protect* the assets on which they are applied. Where it is not practical to isolate a technology, it will be discussed in the DIBCS series report where it is most mission-essential, with cross-references as necessary.

Current Operations and Protection

The Department still is defining its warfighting capabilities and identifying the associated technologies that enable these capabilities, perhaps more in Protection than any other area. Current operations have emphasized the importance of urban warfare and defending against chemical, biological, radiological, nuclear, and explosive (CBRNE) attacks. For example, urban combat experiences in Iraq are highlighting new Department needs—such as jamming improvised explosive devices (IEDs) and actively protecting against rocket propelled grenades (RPGs). While DIBCS: Protection identified warfighting capabilities and technologies associated with jamming IEDs and anti-RPGs, technological solutions that provide effective near-term active protective measures against these specific threats have not yet been developed or adapted. Absent technological solutions, industrial base sufficiency cannot yet be assessed—but will be as the technologies develop.

PROTECTION RECOMMENDATIONS

This study identified 629 specific warfighting capabilities supporting Protection. Of these, 440 capabilities were ones in which the United States should maintain a lead of at least one technology generation. These latter warfighting capabilities are associated with 277 critical enabling technologies. The study team assessed 39 of the most important of these technologies and 25 associated component technologies—for a total of 64 priority technologies assessed for industrial base sufficiency. In general, U.S. defense suppliers hold a technological advantage over foreign competitors for Protection capabilities. The study team identified seven Protection leadership or sufficiency of supply issues. Previous DIBCS reports identified six issues in FA and three each in BA and C2. The study team believes that the higher number of issues in Protection and FA is due to the high degree of global competition in the warfighting capability areas associated with actual combat: in this study, of the seven issues, four are issues where U.S. forces have inadequate technology leadership relative to global competitors. As in *DIBCS FA*, *DIBCS: Protection* identified two “Watch List” items, resulting in a total of four “Watch List” items generated in the DIBCS study series to date.

RECOMMENDATION 1

The Department should implement the remedies in this report to address the seven industrial base issues identified in the Protection area, and should continue to monitor the two "Watch List" items.

- Seven industrial base issues need additional attention to obtain or sustain the desired degree of U.S. capability leadership or supplier sufficiency:
  - Non-lethal Millimeter Wave Active Denial System;
  - 30-mm Supercavitating-Supersonic Projectiles;
  - Multi-Spectral Camouflage Cover;
  - Regenerative Chemical-Biological Filtration;
  - Plasma Antenna;
  - Active Magnetic Signature Reduction System;
  - Thermo-Insulating Paint for Low Observable Hullforms.

- Two identified technologies are important because they represent unusual technology solutions that are not likely to be part of the U.S. warfighting arsenal, but could pose challenges to U.S. warfighters if possessed by potential adversaries. These technologies have been added to the "Watch List" for further consideration and potential policy remedies:

  - Towed Fabric Balloon Pressure Sweep;
  - Rigid Polyurethane Foam (RPF).

RECOMMENDATION 2

The Department should establish an Industrial Base Investment Fund (IBIF) to provide better on-ramps for production-ready technologies. These technologies would be nominated by emerging innovative suppliers or company/Department program managers, and implemented via Capability Area Reviews. An IBIF would leverage lessons learned from similar funds/initiatives in the Department and in commercial businesses. ODUSD (IP) will continue refining this concept, planning to fund this vehicle in FY07.

RECOMMENDATION 3

Within the Department, ODUSD (IP) should continue to provide policy guidance and oversight for DoD efforts to strengthen the industrial base and serve as the clearinghouse for these efforts. ODUSD (IP) maintains insight into Service, Defense Agency, and other Department industrial base activities in its day-to-day responsibilities, as well as those involving other parts of the Executive Branch. It will continue to oversee the industrial base impacts of these organizations' individual actions and policies. As part of its clearinghouse responsibilities, ODUSD (IP) will assess Focused Logistics industrial base sufficiency using the capabilities framework, databases, and

policy tools of the DIBCS process; and also identify emerging priority critical technologies against which industrial base sufficiency cannot yet be assessed. ODUSD (IP) then will consolidate, re-evaluate, and update all DIBCS series findings and recommendations; and research and assess other technologies of interest.

THE LARGER DIBCS EFFORT

Protection is the fourth of the DIBCS series. By mid-2005, ODUSD (IP) will complete the initial DIBCS series with the publication of *DIBCS: Focused Logistics*. All DIBCS assessments will be informed by Joint Staff and other sources that update and further define required warfighting capabilities.

DIBCS Report	Publication Date
Battlespace Awareness	January 2004
Command & Control	June 2004
Force Application	October 2004
Protection	December 2004
Focused Logistics	May/June 2005

The DIBCS process provides a rigorous, analytical framework to examine industrial base sufficiency issues for the joint functional concepts most dependent on materiel solutions. Once all five studies have been completed, ODUSD (IP) will address communication and implementation of the DIBCS series' findings. However, the Department already has benefited from the individual studies. For example, the active magnetic signature reduction technology capability identified in the Protection study has already been considered in a CFIUS transaction completed in November 2004.

With regard to policy implementation, in both *DIBCS BA* and *DIBCS C2,* we identified concerns that contractors might favor in-house capabilities or long-term teammate products over more innovative solutions available elsewhere. To address such concerns, the Acting USD (AT&L) in July 2004 issued guidance for Service Acquisition Executives, Program Executive Officers, and program managers to ensure that they do not cede to vertically integrated prime contractors the ability to select internal capabilities at the expense of better capabilities available from external sources. Instead, he directed DoD program officials to retain the right to disapprove such sub-optimized subcontracting decisions.

While work on the DIBCS series is not complete, the vernacular and methodology it deploys already are being echoed in U.S. and foreign corporations interested in supplying technology for future generations of warfighters. In fact, numerous foreign governments have expressed an interest in adapting the DIBCS methodology to assessments of their industrial bases. An ODUSD (IP) team recently completed DIBCS series briefings in Australia and similar initiatives are in the planning stages for Germany, Sweden, and the United Kingdom.

If disparate industrial base capabilities are to improve warfighting capabilities, sufficiency analyses and the associated industrial base planning must begin with a broad understanding of *warfighting capabilities* required. To base assessments on what is currently available in a given industrial base or on individual constituent interests dooms the warfighter and the industrial base to the status quo. Only by looking to the

future can the Department transform the industrial base to support the operational ethos: warfighting capabilities, and the warfighter, must drive DoD demand and the products the Department acquires. The DIBCS series does this for the Department. ODUSD (IP) believes that long after the study series is completed, the DIBCS framework and findings will continue to inform other federal agency, industry, and allied nation processes related to industrial base issues.

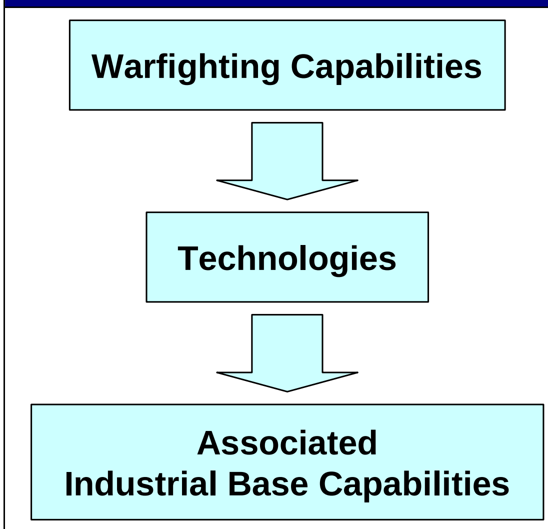
PART I

MEETING THE CHALLENGE

The February 2003 report, *Transforming the Defense Industrial Base: A Roadmap*, reflected a revolutionary warfighting doctrine then germinating within the Department. Since then, the Department has organized around functional concepts defined by the Joint Staff that focus the Department's resources on the most essential operating effects that the U.S. warfighter must deliver in order to win. To help the industrial base respond to this new challenge, the Defense Industrial Base Capabilities Study (DIBCS) series communicates these needs and this capabilities-based approach, as well as identifies and recommends remedies for industrial base issues.

ROADMAP TO THE FUTURE

DEFENSE INDUSTRIAL BASE CAPABILITIES STUDY TRANSLATION PROCESS



Source: Booz Allen Hamilton and ODUSD (IP)

The DIBCS series represents a structured, top-down analysis and policy framework with which Department decision-makers can harness the full power of competition to address key warfighting capabilities and unleash innovation in academia, industry, and the Government. The DIBCS series identifies warfighting capabilities, the critical enabling technologies that support those warfighting capabilities, and the industrial base capabilities associated with those technologies. The series also highlights and addresses industrial base concerns across life cycles of programs.

The Department's move towards capabilities-based planning will fundamentally change the defense enterprise. It is changing the manner in which the Department identifies and prioritizes military capability requirements, focusing its attention on enabling capabilities—often acquired in families- or systems-of-systems. Inherent in this shift are changes in doctrine and the way the Department manages the development and acquisition of these capabilities. How the Department looks at what it has and what it needs will also affect who participates in the defense industrial base—and challenge the Department to make better use of a broader base of suppliers.

The Joint Staff's initial five functional concepts where materiel solutions are most important are: Battlespace Awareness (BA), Command and Control (C2), Force Application (FA), Protection, and Focused Logistics (FL). Translating these concepts extends a common and comprehensive vernacular from the operators to the acquirers

and industry. The landscape of the future, as depicted on the cover of this report and illuminated on the flyleaf, is still evolving. Accordingly, ODUSD (IP) continues to adjust its industrial capability assessments to reflect the latest evolution of the Department's concepts. This integrated vision will improve the efficiency of resource and operational planning, and associated decision-making and program execution within the Department and industry. Applying these tools with diligence will greatly increase the Department's confidence that critical industrial base capabilities are available when needed to maintain U.S. warfighting superiority. It will be up to the Department leadership to structure programs that effectively draw on industrial base capabilities to meet warfighters' 21st century requirements.

THE DEFENSE INDUSTRIAL BASE CAPABILITIES STUDY METHODOLOGY

The Department's industrial policy challenge is to evaluate the industrial base in this new capabilities-based framework and recommend actions and policies to ensure the industrial base can develop the technologies and produce the systems and weapons required.

JOINT STAFF JOINT FUNCTIONAL CONCEPTS[2]	
Battlespace Awareness Global Hawk, DCGS, NPOESS, SBIRS-High, E-2 Advanced Hawkeye	Capabilities of commanders and force elements to understand their environment and the adversaries they face. Uses a variety of surveillance capabilities to gather information; a harmonized secure netcentric environment to manage this information; and a collection of capabilities to analyze, understand, and predict.
Command and Control[3] FBCB2, AOC-WS, MPS	Capabilities that exercise authority and direction over forces to accomplish a mission. Involves planning, directing, coordinating, and controlling forces and operations. Provides the means to recognize what is needed and ensure that appropriate actions are taken.
Force Application JDAM, MM III, F/A-22, MH-60R, JSF, CVN21, FCS, GMLRS	Capabilities to engage adversaries with lethal and non-lethal methods across the entire spectrum of conflict. Includes all battlefield movement and dual-role offensive and defensive combat capabilities in land, sea, air, space, and information domains.
Protection ATIRCM/CMWS, PAC-3, Chem Demil	Capabilities that defend personnel (combatant and non-combatant), physical assets, and information of the United States, allies, and friends from explosive, chemical, biological, nuclear, radiological, air, missile, and cyber attack.
Focused Logistics C-130, CH-47, GCSS, MPF, T-AKE, C-17, FMTV, MH-60S, C-5 RERP	Capabilities to deploy, redeploy, and sustain forces anywhere in or above the world for sustained, in-theater operations. Includes traditional mobility functions of airlift, sealift, and spacelift as well as short-haul (intra-theater and battlefield) transportation. Also includes logistics C2, training, equipping, feeding, supplying, maintaining and medical capabilities.
Source: Joint Functional Concepts and ODUSD (IP)	

The DIBCS series assesses the sufficiency of the industrial base for priority critical technologies in each functional capability area. These studies use the same

[2] A sampling of major programs is aligned with each functional concept to provide an illustration of that area's scope. Not all of the warfighter capabilities supplied by a program fall into a single sector, however. All acronyms are defined in the Acronym List beginning on page 55.
[3] A new functional concept, Network Centric Operations (NCO), has recently been developed. The *DIBCS C2* report published in June 2004 included capabilities relevant to that functional concept. As the NCO functional concept is finalized, the DIBCS series will be reviewed for completeness in assessing the NCO industrial base capabilities.

methodology to assess critical technology and industrial base capabilities in each functional capability area.[4] The methodology is consistent with the operational ethos embodied in the U.S. defense industrial base: warfighting capabilities, and the warfighter as the primary constituent, must drive DoD demand and the products the Department acquires.

This methodology categorizes warfighting capabilities according to the advantage they give the United States over potential adversaries. As described in the table below, extra attention is focused on those warfighting capabilities where the United States should lead any potential adversary. Less attention is focused where leadership is not possible or not particularly advantageous. Ideally, the Department would wish to have a significant lead in every warfighting capability. Practically, however, the Department cannot do so.

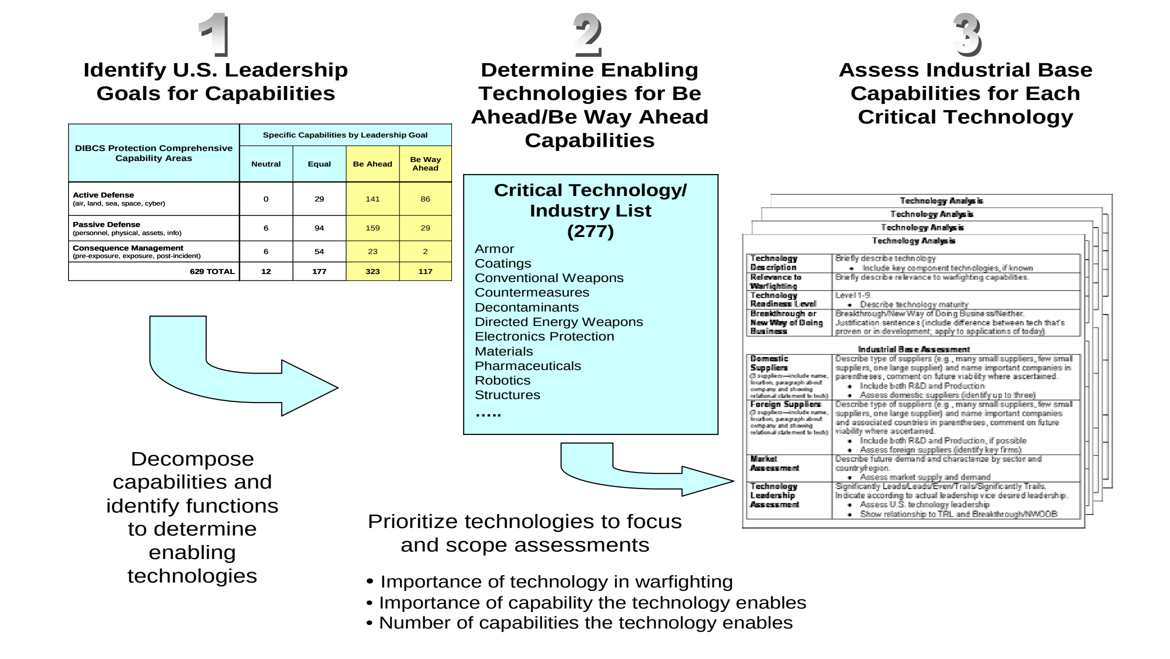
LEADERSHIP GOALS	
Neutral	Position relative to potential adversaries is immaterial.
Equal	Desire capability at least as good as potential adversaries; systems are likely in a common technological generation.
Be Ahead	Desire a significant capability difference over potential adversaries; systems should likely lead by a technology generation or order of magnitude better performance in key attributes.
Be Way Ahead	Desire a very significant capability difference over potential adversaries; systems should likely lead by multiple technology generations or orders of magnitude in performance.
Source: Booz Allen Hamilton and ODUSD (IP)	

In addition, operational concepts will change over time, and the Department should focus most on those capabilities where leadership will provide the warfighter the greatest advantage. The DIBCS methodology gives added weight to the most important of these technologies. The objective is to concentrate DoD attention and scarce resources on the areas that make the biggest difference in 21st century joint military operations: those warfighting capabilities for which the Department must have *Be Ahead* and *Be Way Ahead (BA/BWA)*[5] leadership goals.

Therefore, the methodology focuses on the warfighting capabilities where the Department needs to achieve and maintain the greatest lead; then the study team identifies the priority critical technologies that enable these capabilities and provides assessments of the associated industrial base. When an industrial base deficiency—whether immediate or projected—is identified, the study team examines it in more depth and recommends remedies.[6] This analytical process, further elaborated on the next page, has three basic steps: identify warfighting capability leadership goals; determine and prioritize associated technologies; and assess the industrial base associated with those technologies.

[4] Adapted from the *Space R&D Industrial Base Study*, Booz Allen Hamilton, August 2002.
[5] For clarity, functional capabilities, leadership goals, and policy tools are italicized; Joint Staff operational capabilities are in quotation marks.
[6] For a more detailed discussion of potential policy remedies, see Appendix D.

DEFENSE INDUSTRIAL BASE CAPABILITIES STUDY METHODOLOGY[7]



Source: Booz Allen Hamilton and ODUSD (IP)

1. <u>Identify U.S. Leadership Goals for Warfighting Capabilities</u>. This industrial base study series uses research and analysis teams of subject matter experts to identify detailed warfighting capabilities derived from other documents such as the Joint Staff's functional concepts and the *Universal Joint Task List.*[8] A DIBCS Senior Advisory Group (SAG), composed of retired senior military and civilian DoD leaders and selected industry experts, guides the subject matter experts. The DIBCS SAG then oversees the selection of the leadership

DIBCS PROTECTION SENIOR ADVISORY GROUP
WITH FORMER RELEVANT POSITIONS AND EXPERTISE NOTED*

Gen. (Ret) Thomas S. Moorman, Jr. *[(a)]*
Vice Chief of Staff, USAF
VADM (Ret) Lyle G. Bien *[(b)]*
Deputy Commander in Chief, USSPACECOM
Commander, Carrier Battle Group 7, embarked in USS Nimitz
Mr. Cosmo DiMaggio III *[(c)]*
Industry Expert, Technology Research
LTG (Ret) Robert Noonan *[(a)]*
Deputy Chief of Staff, Intelligence, Army
RADM (Ret) Robert M. Nutwell *[(a)]*
Deputy Asst Secretary of Defense for C3I
Commander Abraham Lincoln Battle Group and Combined Task Force Fifty
Ms. Renata F. Price *[(a)]*
Science Advisor, Deputy Chief of Staff, Research, Development and Acquisition, Army Materiel Command
Dr. Edward L. Warner *[(a)]*
Asst Secretary of Defense for Strategy and Requirements
Asst Secretary of Defense for Strategy and Threat Reduction
Mr. Harry Kingsbery *[(a)]*
Chief, Space & Nuclear Forces, Air Force XOFS
Chief, Space Control, HQ Air Force Space Command

* All Department and military affiliations are former positions; SAG composition varies by functional area.
(a) Currently with Booz Allen Hamilton
(b) Independent Consultant
(c) Currently with the Tauri Group

[7] U.S. leadership goals for warfighting capabilities are characterized by the terms *Neutral, Equal, Be Ahead, Be Way Ahead*. U.S. technology leadership is characterized by the terms *Leads, Even,* and *Trails* as compared to non-U.S. suppliers.
[8] Chairman of the Joint Chiefs of Staff Manual 3500.04C, Universal Joint Task List, July 1, 2002.

goal for each identified capability based on the advantage it provides the United States in executing joint operations in the 21st century.[9]

2. Determine and Prioritize Critical Technologies for *BA/BWA* Warfighting Capabilities. Once these capability goals have been vetted by the Department, the team identifies the critical enabling technologies for those warfighting capabilities with leadership goals rated *BA/BWA*. The DIBCS SAG oversees a team of subject matter experts to identify and prioritize these technologies, using a variety of sources such as the *Joint Warfighting Science and Technology Plan.*[10] The study team then establishes the priority of a technology using three factors. The first factor is the importance of the technology in enabling warfighting impact in a breakthrough, transformational, or critically essential manner. The second factor is the importance of the specific capability the technology enables: for example, it is more important to enable a *BWA* than a *BA* capability. The third factor is the span of impact of the technology in enabling multiple capabilities.

3. Assess Industrial Base Capabilities for Each Priority Critical Technology. The study team then examines the industrial capabilities necessary to supply these critical technologies, in priority order. This generally involves identifying the major domestic and foreign suppliers and examining them for sufficiency and suitability. The study team focuses on a limited number of high priority, critical technologies, which are examined in detail. The purpose of the initial assessment is to form a broad understanding of sufficiency and risk in the most important elements of each functional capability area's industrial base. If this assessment identifies a concern, the study notes the deficiency and potential remedies for further investigation. The study team documents the remaining technologies so they can be addressed to the same level of detail later, as resources permit.

The Role of the Global Industrial Base: The Small Arms Protective Insert (SAPI) Example

DoD requirements and procurements of body armor have greatly increased over the last two years, straining domestic industry's ability to meet DoD requirements for the ballistic backing material incorporated into the small arms protective insert (SAPI). To meet its surging demands, the Department is utilizing delegated authority from the Department of Commerce to use the Defense Priorities and Allocations System (DPAS) to allocate production to respond to the most pressing DoD needs. By January 2004, sole source domestic supplier Honeywell dramatically increased its capacity and there was sufficient body armor in Iraq for all DoD personnel.

However, despite significant increases, available capacity continues to lag steadily increasing demand. Also in 2004, Dutch State Mines (DSM) opened a U.S. facility. This addition has significantly increased the capacity available to the Department, while also enhancing competition and providing U.S. jobs by leveraging a heretofore non-U.S.-located supplier to the benefit of U.S. warfighters. The Department continues to outfit the rest of the force, and meet other DoD requirements, on an accelerated timeline using DPAS. Finally, the Department is encouraging both contractors to increase their U.S. production capacity.

[9] See Appendix A for DIBCS Protection Capability Framework.
[10] United States, Director, Defense Research and Engineering, Department of Defense, Joint Warfighting Science and Technology Plan, February 2002.

Part of this assessment is to compare domestic industrial capabilities with foreign capabilities. To provide the best capability possible to the warfighter, the Department will look for best value throughout the global industrial base. If the Department uses a foreign supplier to support a *BA/BWA* capability, however, it must manage certain risks this could entail. Broadly, these risks are: assurance of supply, technology security, and congruency of strategic interests. Assurance of supply relates to having access to the defense products the Department needs when it needs them. Technology security relates to controlling potential adversary access to the U.S. and non-U.S. industrial base that supplies our warfighters. Congruency of strategic interest describes the desired alignment of corporate interests and strategic planning with U.S. interests and objectives. In assessing whether particular foreign sources represent acceptable risk, the Department must look at numerous factors including the criticality of the technology involved, the status of foreign relations with the other countries involved, and the likely leverage the U.S. can have on the focus of foreign sources**.**

JUST THE BEGINNING

This capabilities-based framework will help decision-makers understand and address industrial base deficiencies. The first round of studies will be completed in 2005. However, this is just the beginning. The baseline will continue to evolve as the Joint Staff implements its joint functional concepts and as the Department simultaneously continues to assess the industrial base supplying those corresponding capabilities. The study series should help companies large and small—and indeed the whole of the industrial enterprise—have more direct insight into the critical industrial base capabilities required for 21st century warfare. This insight should better inform individual firm strategic planning and investment decisions.

The DIBCS series develops a logical, capabilities-based approach to identifying and understanding industrial base sufficiency. It fits naturally into the evolving acquisition and requirements processes. It also provides a firm basis for identifying industrial base deficiencies and potential remedies.

PART II

INDUSTRIAL BASE CAPABILITIES IN PROTECTION

The DIBCS series defines technology and industrial base requirements based on leadership goals for U.S. warfighting capabilities and the defense programs that will deploy them. This study applies the DIBCS methodology to the Protection functional capability area, establishing leadership goals for Protection warfighting capabilities. Using this warfighting capabilities-based analysis, the study identifies technologies which enable the functional concept and provides an assessment of the industrial base for a prioritized subset of those technologies. It also develops a "Watch List" of unique technologies that represent unusual technical solutions and could pose challenges to U.S. warfighters if possessed by potential adversaries.

REFINING THE PROTECTION FUNCTIONAL CAPABILITY AREA

As stated in the Joint Functional Concept (JFC), Protection warfighting capabilities include the ability to detect and assess threats, provide warning, defend (both actively and passively), and manage consequences (recover). Protection-related technologies come in a wide variety, from armor and stealth to missile defense, computer network security, and chemical agent decontamination. Because warfighting capabilities to detect threats are most closely associated with sensors, they were addressed in *DIBCS BA*. Likewise, *DIBCS C2* addressed warfighting capabilities associated with assessing the threats and providing the necessary warnings. Those warfighting capabilities and technologies associated with offensive weapons and multi-role weapon systems were covered in the Force Application study.[11] Thus, *DIBCS: Protection* concentrates on warfighting capabilities relating to defending against attacks—including national missile defense—and managing consequences. The graphic below depicts Protection Joint Functional Concept (PJFC) capabilities as translated for *DIBCS: Protection*.

CAPABILITY AREA	DEFINITION	EXAMPLES
Active Defense	Capabilities to actively destroy or neutralize an incoming threat	• Strategic missile defense • Air & missile defense • Anti-torpedo defense • Mine sweeping
Passive Defense	Capabilities designed to passively counter an asset against the effect of the threat	• Armor • Stealth • Immunization • Protective clothing • Computer network security
Consequence Management	Capabilities to manage and mitigate the consequences of a successful attack	• Decontamination • Trauma care

[11] *DIBCS BA*, published January 2004, *DIBCS C2*, published in June 2004, and *DIBCS FA*, published October 2004, are available at www.acq.osd.mil/ip/.

DIBCS: Protection should not be confused with the activities of the Department of Homeland Security (DHS). This study addresses those warfighting capabilities and associated important technologies that meet the warfighting capabilities outlined in the PJFC and used by Combatant Commanders. DHS provides the unifying core for the vast national networks of organizations and institutions involved in securing our nation. Some of the technologies identified during this assessment will be of interest to DHS. They enable passive facility, equipment, and individual protection, and consequence management capabilities applicable to local, state, and national first responders. The findings and remedies included in this study also will be of interest to the Assistant Secretary of Defense for Homeland Defense (ASD(HD)) because the ASD(HD) provides guidance to Combatant Commanders regarding the defense of U.S. territory from all attacks that originate abroad. [12]

At press time for *DIBCS: Protection*, the Joint Staff is reviewing a proposal to further refine functional capability planning. The proposal defines twenty-one joint capability areas that are mapped within the eight existing Functional Capability Boards (FCBs).[13] If this proposal is accepted, some of the warfighting capability areas originally covered in this report may be transferred to other FCBs—for instance, air and missile defense capability and strategic missile defense may move to joint capability areas within Force Application. However, current and future DIBCS series reports will address warfighting capabilities associated with all Joint Staff functional concepts, although they may not align specifically with the evolved Joint Staff functional concepts.

LEADERSHIP GOALS FOR PROTECTION WARFIGHTING CAPABILITIES

The DIBCS series employs a systematic methodology for translating warfighting capabilities to the technology and industrial base vernacular in order to assess industrial base sufficiency. Using the Joint Staff's PJFC as the backdrop, the study team derived capability leadership goals the United States should strive to maintain for each of the 629 Protection warfighting capabilities summarized in the chart on the facing page.[14]

[12] Identification of defense industrial facilities for critical infrastructure protection is within the purview of the Deputy Under Secretary of Defense (Industrial Policy) in concert with the Assistant Secretary of Defense (Homeland Defense), but is not in the scope of this study and exceeds its classification level.
[13] The eight Functional Capability Boards are: Battlespace Awareness, Command & Control, Net-Centric Operations, Force Application, Protection, Focused Logistics, Force Management, and Training.
[14] See process described on page 17.

PROTECTION WARFIGHTING CAPABILITIES SUMMARY CHART					
Capability Area	**Mission**	**Degrees of Capability Leadership**			
		Neutral	**Equal**	**Be Ahead**	**Be Way Ahead**
Active Defense	Air	0	0	50	35
	Sea	0	8	31	11
	Land	0	17	29	2
	Space	0	4	15	35
	Cyber	0	0	16	3
Passive Defense	Personnel	6	35	41	4
	Physical Assets	0	59	80	21
	Information	0	0	38	4
Consequence Management	Pre-Exposure	0	5	17	0
	Exposure	6	28	6	2
	Post-Incident	0	9	0	0
	Platform Recovery	0	12	0	0
629 Total		12	177	323	117
Source: Booz Allen Hamilton and ODUSD (IP)					

The table immediately below highlights some of the specific findings of *DIBCS: Protection* and puts them in the context of our previous studies. Of the 629 Protection warfighting capabilities, 440 (70 percent) were assessed as *BA/BWA* capabilities—slightly lower than the *BA/BWA* proportions established in the studies on Battlespace Awareness, Command and Control, and Force Application.

WARFIGHTING CAPABILITY GOALS			
Functional Concept	**BA**	**BWA**	**BA/BWA**
Protection	51%	19%	70%
• Active Defense	55%	34%	89%
• Passive Defense	55%	10%	65%
• Consequence Management	27%	2%	29%
Command & Control	58%	16%	74%
Battlespace Awareness	39%	43%	82%
Force Application	38%	38%	76%
Source: Booz-Allen Hamilton and ODUSD (IP)			

It is, however, a unique aspect of Protection and C2 warfighting capabilities that proportionately fewer capabilities are assessed as *BWA* (19 and 16 percent, respectively), whereas *BWA* capabilities in the BA and FA studies averaged 40 percent (specifically 43 and 38 percent, respectively). This is because both Protection and C2 capability areas rely more heavily on the Department adopting technologies and

products from the commercial world and adapting them for military applications. For example, many commercial products associated with the medical field, law enforcement, and emergency management address "Consequence Management" capabilities. In some cases, commercial technologies and products from the sporting goods, hunting, and fishing industries address "Passive Defense" capabilities associated with personnel and equipment protection—such as, fabrics and materials for lightweight suits and camouflage technologies. For C2, these technologies and products are mostly associated with commercial information technology (IT) products. As such, DoD leadership by more than one technology generation is neither necessary, nor practical.

However, for Protection's "Active Defense" capabilities, the study team assessed the vast preponderance of these capabilities (89 percent) as *BA/BWA* because nearly 60 percent are related to missile defense—a unique military capability that represents the highest priority of U.S. national security concepts. In this capability area, the operational commander must be able to draw upon numerous engagement techniques to destroy and defeat an enemy attack. For example, ballistic missile defense capabilities must be able to defend against multiple enemy ICBM/IRBM launches through all phases of their launch trajectory with a wide array of options from land, air, sea, and space. *BA/BWA* capabilities not related to missile defense include destroying a torpedo at various ranges and terminating simultaneous, coordinated and distributed attack against our defense information networks–-important for protecting critical sea- and cyber-based assets vital to national and operational security.

As discussed earlier, in Protection's "Passive Defense" capability area, the study team determined that commercially-available technologies enabled many warfighting capabilities, whether they have an *Equal* or *BA/BWA* leadership goal. For example, it is acceptable for the United States to have *Equal* capability relative to an adversary's ability to protect individuals from electromagnetic devices and acoustic directed energy such as high voltage and very loud, shrill noises. The technologies to support this capability are employed in commercial and industrial settings to comply with worker safety standards or to enhance working environments. On the other hand, as the Department has witnessed in Operation Enduring Freedom and Operation Iraqi Freedom (OEF/OIF), soldiers are becoming more integrated with the weapon systems they use. As such, it is imperative that the United States have *BA/BWA* capabilities to protect an individual from chemical, biological, and radiological (CBR) contamination with impermeable, protective clothing that doesn't impact manual dexterity, or hamper an individual's ability to communicate orally or maintain sensory awareness.

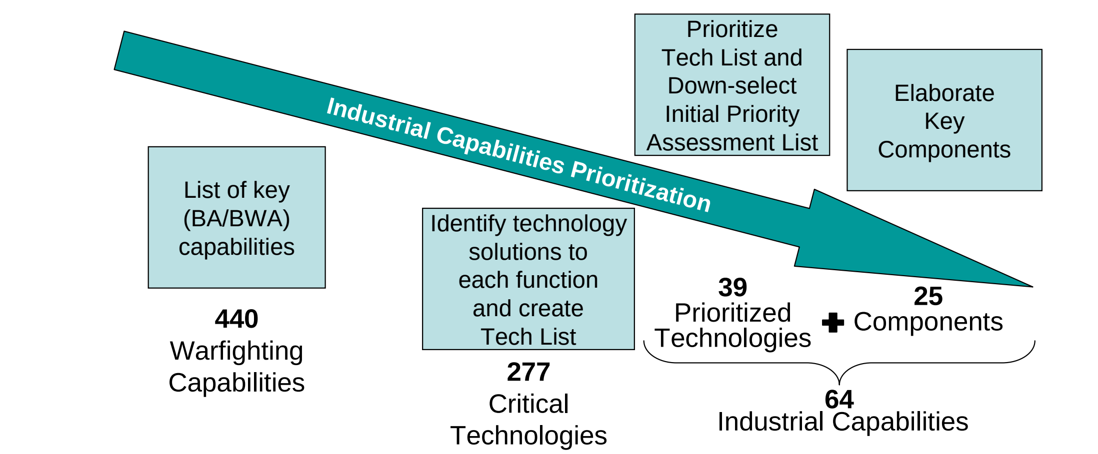
The study team established *Neutral* or *Equal* leadership goals for 71 percent of the "Consequence Management" warfighting capabilities—often because of readily available, innovative, commercial solutions. Nevertheless, for "Consequence Management" capabilities such as rapid decontamination of fixed sites, equipment, aircraft, and vehicles, as well as for immediate medical response, it is important that the United States have *BA/BWA* capabilities. This is because of the requirement to network and fully integrate on-site triage and trauma care for individuals with overall combat

planning functions. Clearly, the ability of U.S. forces to rapidly recover from an enemy attack is essential to warfighting capability in ways that patient recovery in non-military scenarios is not.

THE TECHNOLOGY PRIORITIZATION & ASSESSMENT PROCESS

The study team established leadership goals for Protection warfighting capabilities and identified critical technologies that enabled *BA/BWA* warfighting capabilities. The DIBCS SAG oversaw a team of subject matter experts that prioritized the critical technologies and associated component technologies. The illustration below summarizes this process.

PROTECTION TECHNOLOGY PRIORITIZATION PROCESS



Warfighting Capability: A specific ability derived from the Joint Staff Protection Functional Capability Concept

Critical Technology: A technical method enabling one or more *BA/BWA* warfighting capabilities

Component: A subset technology used in the assembly of an enabling technology

Industrial Capability: The ability of a manufacturer to supply or produce a technology

Sources: Booz Allen Hamilton and ODUSD (IP)

This study identified a total of 277 critical technologies enabling the 440 *BA/BWA* warfighting capabilities.[15] All 277 critical technologies and that portion of those that represent priority critical technologies are categorized into 20 broad industrial areas, as shown on the following page. The study team evaluated industrial sufficiency for the 39 most pressing critical technologies and 25 associated components.[16] The study team identified no priority critical technologies within the area of Acoustic Energy weapons.

[15] These warfighting capabilities and critical technologies are discussed in Appendices A and B.
[16] These technologies were present in 19 of the 20 broad industrial areas.

BROAD INDUSTRIAL AREAS FOR PROTECTION			
Industrial Areas	Technologies for *BA/BWA* capabilities	Priority Critical Technologies Assessed	
		Technologies	Components
Countermeasures	44	5	2
Computer Network Defense	31	4	4
Signature Reduction	29	2	0
Countermine	21	2	0
Directed Energy Weapons	18	1	2
Textiles	16	2	0
Conventional Weapons	16	1	1
Decontaminants	14	2	0
Structures	13	2	5
Kinetic Energy Weapons	12	3	5
Materials	11	2	0
Filters	9	2	0
Armor	8	3	0
Electronics Protection	7	1	2
Pharmaceuticals	7	2	0
Propulsion	6	2	2
Robotics	6	1	0
Area Denial	4	1	2
Coatings	4	1	0
Acoustic Energy Weapons	1	0	0
Total	277	39	25
Sources: Booz Allen Hamilton and ODUSD (IP)			

The chart opposite lists the 39 priority critical technologies and the 25 component technologies assessed. The industrial sufficiency assessment identified a total of 227 companies, laboratories, and universities involved in the 64 technologies and components investigated. This supplier list is summarized in Appendix C. While the summary does not include every supplier in these industrial areas, it illustrates the overall strength of the domestic Protection industrial base. It also indicates the strength of foreign suppliers in this industry segment.

Senior officers who participated as Red Team members in the review of this study pointed out that certain problematic combat capabilities, not assessed as industrial base sufficiency issues, are required to deal with evolving threats during nation-building operations in an urban environment. For example, in the cases of improvised explosive devices (IEDs) and rocket propelled grenades (RPGs), specific technological solutions that provide effective near-term active protective measures against these threats have not yet been developed or adapted. Absent a technological solution, industrial base sufficiency cannot yet be assessed. The study team intends to assess industrial base sufficiency associated with such technologies for all DIBCS series assessments, as technological solutions emerge.

39 Protection Technologies and 25 Components Assessed for IB Sufficiency[17]	
1. Non-Lethal Millimeter Wave Active Denial System - Flat Parabolic Surface Antenna - Gyrotron Millimeter Wave Source 2. Electrified Anti-RPG 3. Lightweight Armor Materials 4. Smart Armor 5. Biometric Authentication Technologies - Face Recognition - Optical Fingerprint Scanner - Iris Scanner - Voice Recognition 6. Heuristic Scanner 7. Multi-Level Secure System 8. RFID Tagging 9. Laser Reflective Coating 10. Extended-Range Active SAM - Missile Propulsion 11. Dispersible Kinematic Flare (Smart Flare) 12. Mobile, Re-Programmable Acoustic Decoy 13. Plasma Antenna - Non-Metallic Substrates - Switch Backplanes 14. Selective-Reactive RF Jamming 15. Expendable Programmable Acoustic Decoy 16. Rigid Polyurethane Foam 17. Towed Fabric Balloon Pressure Sweep 18. Chemical Agent-Degrading Bioengineered Enzymes 19. Topical Skin Protectant/Decontaminant 20. Laser Relay Mirror - Control System - Mirrors/Optics 21. EMP Hardening - EMP-Hardened Semiconductors - EMP Metallic Shielding	22. Multiwave Laser Eye Protection 23. Regenerative Chem-Bio Filtration 24. 30-mm Supercavitating – Supersonic Projectile (SC-SSP) 25. Kinetic Energy Interceptor (KEI) - Booster - Kill Vehicle 26. Miniaturization Technologies for Kill Vehicles - Miniaturized Attitude Motors - Miniaturized GNC System - Miniaturized Seeker 27. Blast and Energy Absorbing Material 28. Glass Fiber Reinforced Plastic 29. Synthetic Universal Blood Substitute 30. Genetically Engineered Inoculation 31. Dual-Pulse Third Stage Rocket Motor for Interceptor - Ceramic Rocket Nozzle 32. Rapid Acceleration Booster for Boost/Mid-Course Interceptor - Solid Fuel Rocket Motor Vectorable Nozzle 33. Crawling UUV 34. Active Magnetic Signature Reduction System 35. Composite Radar Absorbing Material 36. Low-Observable Hullform - Low-Observable Antenna - Thermo-Insulating Paint 37. Miniaturized Satellites/Nano-Satellites - Nano-Satellite Bus - Miniaturized Star-Tracker - Miniaturized Sun Sensor 38. Multi-Spectral Camouflage Cover 39. Ultra-Lightweight Protective Suit
Source: Booz Allen Hamilton	

A by-product of this analysis has been the successful application of a methodology that uses the Joint Staff's joint functional concepts as a basis for focusing the industrial base on those technologies necessary to assure continued U.S. leadership in the most important warfighting capabilities. The percentage of Protection *BA/BWA* capabilities (70 percent) is slightly lower than those in the already published DIBCS studies (BA: 82 percent, C2: 74 percent, FA: 76 percent). Collectively, *BA/BWA* warfighting capabilities within the four reports represent about 75 percent of all identified warfighting capabilities. The DIBCS construct will help the Department and industry focus on the priority critical technologies that enable the most challenging (*BA/BWA*) warfighting capabilities. This focus will help ensure that the products for the 21st century military operations envisioned in the joint functional concepts are available to the warfighter.

[17] Components associated with the technologies are indented.

CRITICAL INDUSTRIAL AND TECHNOLOGY DEFICIENCIES AND ISSUES

The study team identified 39 priority critical technologies and 25 associated components within the 277 critical technologies. Generally, the industrial base supporting Protection is robust. The study team determined that the industrial base supporting 55 of 64 assessed technologies and components was sufficient, as shown in the table below.

55 PROTECTION TECHNOLOGIES/COMPONENTS WITH SUFFICIENT INDUSTRIAL BASE[18]	
1. Non-Lethal Millimeter Wave Active Denial System – Flat Parabolic Surface Antenna 2. Non-Lethal Millimeter Wave Active Denial System – Gyrotron Millimeter Wave Source 3. Electrified Anti-RPG [19, 20] 4. Lightweight Armor Materials 5. Smart Armor 6. Biometric Authentication Technologies 7. Biometric Authentication Technologies – Face Recognition 8. Biometric Authentication Technologies – Optical Fingerprint Scanner 9. Biometric Authentication Technologies – Iris Scanner 10. Biometric Authentication Technologies – Voice Recognition 11. Heuristic Scanner 12. Multi-Level Secure System 13. RFID Tagging 14. Laser Reflective Coating 15. Extended-Range Active SAM[21] 16. Extended-Range Active SAM – Missile Propulsion 17. Dispersible Kinematic Flare (Smart Flare) 18. Mobile, Re-Programmable Acoustic Decoy[19] 19. Plasma Antenna – Non-Metallic Substrates 20. Plasma Antenna – Switch Backplanes 21. Selective-Reactive RF Jamming [20,21] 22. Expendable Programmable Acoustic Decoy 23. Chemical Agent-Degrading Bioengineered Enzymes 24. Topical Skin Protectant/Decontaminant 25. Laser Relay Mirror 26. Laser Relay Mirror – Control System 27. Laser Relay Mirror – Mirrors/Optics 28. EMP Hardening 29. EMP Hardening – EMP-Hardened Semiconductors 30. EMP Hardening – EMP Metallic Shielding	31. Multiwave Laser Eye Protection 32. Kinetic Energy Interceptor (KEI) 33. Kinetic Energy Interceptor (KEI) – Booster 34. Kinetic Energy Interceptor (KEI) – Kill Vehicle 35. Miniaturization Technologies for Kill Vehicles 36. Miniaturization Technologies for Kill Vehicles – Miniaturized Attitude Motors 37. Miniaturization Technologies for Kill Vehicles – Miniaturized GNC System 38. Miniaturization Technologies for Kill Vehicles – Miniaturized Seeker 39. Blast and Energy Absorbing Material 40. Glass Fiber Reinforced Plastic 41. Synthetic Universal Blood Substitute 42. Genetically Engineered Inoculation 43. Dual-Pulse Third Stage Rocket Motor for Interceptor [21] 44. Dual-Pulse Third Stage Rocket Motor for Interceptor – Ceramic Rocket Nozzle 45. Rapid Acceleration Booster for Boost/Mid-Course Interceptor 46. Rapid Acceleration Booster for Boost/Mid-Course Interceptor – Solid Fuel Rocket Motor Vectorable Nozzle 47. Crawling UUV 48. Composite Radar Absorbing Material 49. Low-Observable Hullform 50. Low-Observable Hullform – Low-Observable Antenna 51. Miniaturized Satellites/Nano-Satellites 52. Miniaturized Satellites/Nano-Satellites – Nano-Satellite Bus 53. Miniaturized Satellites/Nano-Satellites – Miniaturized Star-Tracker 54. Miniaturized Satellites/Nano-Satellites – Miniaturized Sun Sensor 55. Ultra-Lightweight Protective Suit
Source: Booz Allen Hamilton	

[18] Components associated with the technologies are indented.
[19] Technology early in development.
[20] Industrial base sufficiency for RPG protection and IED jamming will be assessed once specific technology solutions emerge.
[21] Assessed as sufficient because the United States leads technologically and market size is limited.

Of the nine technologies and components[22] for which issues were identified, seven may require remedies and two bear further monitoring on the "Watch List."

The seven technologies assessed as having an insufficient or potentially insufficient industrial base are:

- Non-lethal Millimeter Wave Active Denial System;
- 30-mm Supercavitating-Supersonic Projectiles;
- Multi-Spectral Camouflage Cover;
- Regenerative Chemical-Biological Filtration;
- Plasma Antenna;
- Active Magnetic Signature Reduction System;
- Thermo-Insulating Paint for Low Observable Hullforms.

The two "Watch List" technologies are Towed Fabric Balloon Pressure Sweep and Rigid Polyurethane Foam.

ISSUES IN THE PROTECTION INDUSTRIAL BASE

The table on the following page summarizes the seven industrial base sufficiency issues identified in this assessment. Each technology, its link to warfighter capabilities, and the industrial base issues are described in detail. U.S. leadership goals for warfighting capabilities are characterized by the terms *Neutral, Equal, Be Ahead, Be Way Ahead*; U.S. technology leadership relative to non-U.S. suppliers is characterized by the terms *Leads, Even,* and *Trails*.

<u>Non-Lethal Millimeter Wave Active Denial System</u>. The Active Denial System (ADS) is a non-lethal, counter-personnel directed energy weapon. This is a breakthrough technology that uses millimeter-wave electromagnetic energy to stop, deter, and turn back an advancing adversary. The next step is to complete government acceptance testing and military utility assessment. This activity is being conducted under an Advanced Concept Technology Demonstration (ACTD) program in order to rapidly move the system into the hands of warfighters. The Air Force Research Laboratory is leading this effort with its weapon system integrator, Raytheon. The United States appears to be the only source of this type of technology and application. At this time, ADS technology is being developed exclusively for military use. Future applications in the "Consequence Management" capabilities of military peacekeeping and/or law enforcement may not be adequately served by only one source. Indeed, the demand for this technology for non-military applications could encroach on the supply available to the Department if not remedied early.

---

[22] The primary objective of this study is to identify warfighting capabilities and enabling technologies in Protection and assess the supporting industrial base, addressing deficiencies. Resources limited the initial assessment to 64 priority critical technologies and components. The ODUSD (IP) staff will continue to evolve the baseline established in this study, update the capability framework and critical technology lists, perform additional assessments of critical technologies, and identify additional industrial base issues.

Issues in the Protection Industrial Base					
Technology		Industrial Base Sufficiency Analysis			Rationale (for associated remedies, see page 43)
		Domestic Sources	Foreign Sources		
Active Defense	Non-Lethal Millimeter Wave Active Denial System	1	0		This technology provides the ability to selectively control individual or group area access/transit without causing harm. It uses millimeter-wave electromagnetic energy to stop, deter, and turn back adversaries. One U.S. supplier may not be sufficient.
Active Defense	30-mm Supercavitating-Supersonic Projectiles	3	1[23]		Breakthrough technology that provides surface or air launched projectiles with enhanced water entry, underwater speed, and effective depth penetration against mines, underwater vehicles, and swimmers. Technology leadership is rated *Even* because Russia has been developing this technology for decades. and France and possibly others are believed to have advanced programs. The United States must lead.
Passive Defense	Multi-Spectral Camouflage Cover	2	>3		Mature technology that provides the ability to deny detection of personnel and equipment with no major technology leaps foreseen. U.S. leadership is rated *Even* and is a concern.
Passive Defense	Regenerative Chemical-Biological Filtration	1	3		New way of doing business. Technology allows military vehicles and structures to provide long-lasting filtration without the constant filter replacement. Only one domestic supplier may be a concern.
Passive Defense	Plasma Antenna	3	3		Breakthrough technology that provides light, compact, rapidly reconfigurable antennas resistant to countermeasures and counter detection. Potentially disruptive technology where U.S. leadership has been rated as *Even* and should be monitored closely.
Passive Defense	Active Magnetic Signature Reduction System	2	>3		Mature technology that dynamically compensates to nullify magnetic signatures caused by metallic objects or their motion through the natural environment. U.S. leadership rated as *Even* with foreign suppliers and is a concern.
Passive Defense	Thermo-Insulating Paint for Low Observable Hullforms	2	1		Mature technology used throughout the world that allows for ships to effectively decrease their temperature signature to help avoid infrared detection. U.S. leadership rated as *Even*.
Source: Booz Allen Hamilton and ODUSD (IP)					

<u>30-mm Supercavitating-Supersonic Projectiles</u>. This technology is an anti-mine projectile that is an outgrowth of the proven 20-mm Rapid Airborne Mine Clearance System (RAMICS). RAMICS is a helicopter-based mine countermeasure system designed to neutralize near-surface, floating, and shallow bottom mines. The follow-on

[23] Russia, France, Ukraine, and China may be working in this technology area. However, the limited publicly available information identified only one French research facility.

30-mm technology is expected to be deployed on the U.S. Marines' Expeditionary Fighting Vehicle—formerly the Advanced Amphibious Assault Vehicle. This breakthrough technology consists of gun-fired projectiles that travel supersonically through water. The primary application at this stage is countermine and counter-torpedo. There are several U.S. suppliers and one identified foreign supplier. However, the U.S. technology is rated *Even* relative to a French research facility working in this technology area. Russia also has been developing supercavitating technology since the 1980s and may have a substantial lead as well as suppliers that are not acknowledged publicly. Other nations also may be developing this technology. Publicly available information on this technology is limited.

Multi-Spectral Camouflage Cover. These covers provide protection to equipment, vehicles, and personnel from a variety of sensing technologies, thereby reducing their signatures. The composition of the materials used for these covers are generally considered proprietary to the individual manufacturers. In use, the covers drape over equipment, breaking up the outline of the object. The covers also scatter radar returns that otherwise might bounce off the object. Further, this technology allows for the efficient dispersion of heat from the equipment, reducing the infrared signature.

The study team assessed the United States as *Even* with foreign technology. There are only two U.S. providers and numerous foreign providers. Multiple European companies appear to have market-leading technology. It is important to note that this is a mature technology at a TRL 9, with incremental improvements ongoing but no major leaps foreseen. The major European suppliers sell to militaries and governments worldwide, including the U.S. military and its potential adversaries. While one of the foreign suppliers most advanced in this technology is Saab AB and its U.S.

How DIBCS Will Improve Committee on Foreign Investments in the United States (CFIUS) Decisions: The Multi-Spectral Camouflage Example

Multi-spectral camouflage covers are provided by two firms with production operations in the United States: Millimeter Wave Technology (Passaic, NJ) and Saab Barracuda, a North Carolina-based subsidiary of Saab AB, acquired from BAE North America in April 2002. The Deputy Under Secretary of Defense for Industrial Policy participates in the CFIUS review process to examine the national security impacts of foreign acquisitions of U.S.-located firms. The initial CFIUS review of this transaction noted that the BAE camouflage business was engaged in the development of critical defense technology and was otherwise important to the defense technology base. Because this BAE entity was about to receive a classified contract relating to this technology, Saab proposed putting the business under a Special Security Agreement (SSA) to mitigate risks associated with technology security and enhance congruence of strategic interests. Sweden already was negotiating a DoD Security of Supply (SoS) to assure security of supply. The transaction was approved on this basis.

Had the Department had the DIBCS: Protection report at the time, it would have used the results in the CFIUS examination. While it is unlikely that the transaction would have been blocked on this basis—particularly given that the original technology produced in the U.S. facility was developed by Saab—additional discussions with the new parent would have occurred and additional risk mitigation measures may have been proposed.

As the transaction has developed, Saab Barracuda's SSA has enhanced other U.S. defense customers' confidence in its security as a supplier. In addition, the North Carolina facility that Saab AB purchased in 2002 has increased employment by 120 percent—to 242 employees—in the last two years.

based subsidiary, Saab Barracuda LLC, the proliferation of these products remains of concern. Their ability to defeat U.S. military surveillance is also a concern. However, multi-spectral camouflage cover technology is mature and there are at least two U.S.-located sources of supply.

Regenerative Chemical-Biological Filtration. This technology provides protection from biological and chemical agents in vehicles and structures to ensure safe and breathable air for personnel. It works by adsorbing[24] and containing air contaminants. In order to continuously filter, these systems are fitted with at least two filter beds. While one adsorbs contaminants, the other is cleaned or regenerated by using air from the in-use filter to purge the contaminants from the dirty filter out of the system. There are three main varieties of regenerative filtration systems: temperature swing adsorption, pressure swing adsorption, and pressure and temperature adsorption.

Only one U.S. developer and a military research lab were identified for this technology. The United Kingdom (U.K.) appears to hold a lead in this technology; its two firms are already marketing regenerative filtration devices and have substantial R&D investments. It appears that U.S. military organizations are working with the U.K. firms to gain access to these technologies. This is currently a limited market, but it has the potential to grow in both the military and non-military markets. Only one U.S. supplier may not be acceptable, given the importance of chemical-biological filtration in the current operating environment. However, concerns are mitigated by confidence that the Department will be able to continue to influence the strategic direction of the U.K. firms and because there is a U.S. company in this technology.

Plasma Antenna. These devices are radio frequency (RF) antennas based on plasma rather than metal. This technology will enable the design of antennas that are efficient, low in weight, and smaller in size than traditional wire antennas. The antennas can be undetectable to microwave radar because of their low radar cross-section. Also, when the plasma density is lowered to a certain point, or when the antenna is switched off, the device does not absorb high-powered radiation, reducing the effect of electronic warfare countermeasures. The study team assessed the United States as *Even* with foreign technology, and identified a number of U.S. and foreign developers. This is a breakthrough, potentially disruptive technology with many important military applications.

Active Magnetic Signature Reduction System. This technology is a mature technology currently in production. It dynamically compensates to nullify magnetic signatures caused by metallic objects or their motion through the natural environment. Improvements to this technology are likely to come as advancements in real-time magnetic field measurement systems, which feed into the active magnetic signature reduction systems. The study team assessed the United States as *Even* with foreign technology. The study team identified only two domestic providers (EMS and Foster

[24] Adsorbing refers to the accumulation of molecules of a gas or liquid on the surface of another substance; without actually penetrating the substance they are on. Absorbing refers to the drawing of a gas or liquid into the pores of a permeable solid.

Miller), posing a potential industrial base issue. Moreover, U.K. company QinetiQ recently acquired Foster Miller. As a result of highlighting this issue in this study, during its CFIUS review ODUSD (IP) established reporting mechanisms to monitor the company's strategic direction.

<u>Thermo-Insulating Paint for Low-Observable Hullforms</u>. Thermo-insulating paint protects a ship from detection by infrared sensors. Ships become noticeable by infrared sensors because of radiant intensity, especially in the sun. To overcome this visibility, low-emissive, thermo-insulating paint is used. Thermo-insulating paint lowers the measurable temperature of an object, making a hot object less conspicuous to a thermal sensor. The paint generally works by incorporating microscopic particles that reflect radiant energy in the paint solution. These particles reflect energy back towards the source, providing a barrier for radiated energy, and effectively masking the painted surface.

This technology is currently in production and in use throughout the world. Advances in this technology are unlikely to be revolutionary, but instead will likely happen as gradual product improvements. This technology is an issue because only two domestic suppliers were identified. Surface Optics Corporation (San Diego, CA) provides thermo-insulating paints to commercial and government customers, while Degaussa Building Systems (Shakeopee, MN) manufactures insulating paints for commercial applications. Only one foreign supplier was found, Colebrand International in London, U.K. No country has a clear advantage in the development of thermo-insulating paint technologies, and the United States should lead.

PROTECTION "WATCH LIST" TECHNOLOGIES

"Watch List" technologies represent unusual technical solutions and could pose challenges to U.S. warfighters if possessed by potential adversaries. These potentially disruptive technologies are not planned for U.S. warfighters and represent capability breakthroughs which could leapfrog or enhance existing *BA/BWA* capabilities. *DIBCS: Protection* "Watch List" technologies (presented in the table on the following page) join *DIBCS FA* "Watch List" technologies—and may be joined by "Watch List" technologies for Focused Logistics. The Industrial Base Investment Fund (IBIF) concept could be used as a vehicle to insert "Watch List" technologies into the U.S. arsenal (to be discussed in Part III).

PROTECTION TECHNOLOGY "WATCH LIST"				
Technology	**Industrial Base Sufficiency Analysis**			**Rationale** (for associated remedies, see page 47)
	Domestic Sources	**Foreign Sources**		
Towed Fabric Balloon Pressure Sweep	0	1		This technology replicates aquatic vessel signatures to clear pressure mines. The Australian Defense Science and Technology Organization is spearheading this effort. No U.S. firms or research institutions appear to be working on pressure mine sweep technology of any kind.
Rigid Polyurethane Foam (RPF)	100s	Many		RPF can isolate the effects of explosive mines, in both ground and aquatic environments. It can shield personnel and equipment, thereby making the weapons ineffective. While widely available for commercial ship insulation applications, more investigation is needed with regard to application of this technology in a military sea and land environment.
Sources: Booz Allen Hamilton and ODUSD (IP)				

<u>Towed Fabric Balloon Pressure Sweep</u>. Pressure sweeps are large ocean towable bladders (balloons) made of fabric. Pressure sweeps are used to counter the increasing number of multi-influence (pressure and combination) sea mines. Past attempts at constructing viable pressure sweeps have not been successful. To be successful, a modern pressure sweep must generate a sufficient pressure signature comparable to existing towed acoustic and magnetic sweep systems, at reasonable cost with reasonable explosion resistance. There has never been an effective sweeping device developed to address pressure influence mines despite their increasing danger to the U.S. Navy. The study team assessed the capability to counter pressure influence and combination mines as a *BA* warfighting capability in the "Active Defense" capability area of Protection.

In an Australian initiative, R&D for a fabric sweep concept is being spearheaded by the Defense Science and Technology Organization, with prototype components made by an Australian firm. No U.S. firms or research institutions were found to be working on pressure mine sweep technology of any kind, although one U.S. company unsuccessfully bid to work on the Australian initiative.

<u>Rigid Polyurethane Foam</u>. Rigid polyurethane foam (RPF) is a petrochemical-based material that is being developed to protect individuals and vehicles from explosive mines. RPF has potential applications in a variety of specific countermine applications, such as foam road surfaces, personnel walkways through mine fields, and protection from mines in shallow water and surf zones. Sandia National Laboratory conducted promising testing to establish breach lanes through minefields in 1998, but since then there has been little or no military development. This technology could enable the *BA/BWA* capabilities related to countermine applications in myriad environments: quick flat surfaces (tent floors, maintenance and helicopter pads), as well as difficult transportation environments. RPF technology is common in the commercial world, where U.S. technology leadership is assessed as *Even* with foreign development.

These “Watch List” technologies represent breakthroughs having the potential to significantly alter particular warfighting domains. The immediate concern is that they have no DoD “pull” toward a specific application and no proven countermeasures. If such technologies proliferate, they may disrupt U.S. warfighting advantages. The “Watch List” highlights the existence of these technologies to senior Department leadership for inclusion in future capability planning or as IBIF initiatives—and to prevent the proliferation of potentially disruptive technologies.

In summary, the Department should continue to closely monitor the Protection *BA/BWA* warfighting capabilities, associated priority critical technologies, and industrial base sufficiency—and be prepared to intervene when critical industrial base deficiencies or potentially disruptive technologies are identified. Part III of this report further develops the IBIF concept introduced in *DIBCS FA*. Part IV (beginning on page 43) discusses remedies for issues identified in this section.

(This page intentionally left blank.)

PART III

POLICY IMPLICATIONS

ODUSD (IP) continues to be concerned that production-ready innovation often has limited on-ramps to programs of record. ODUSD (IP) first treated these transitional issues in case studies of 24 emerging defense suppliers published in February 2003. The *DIBCS FA* report recommended that the Department establish an IBIF to provide better on-ramps for production-ready technologies that are nominated by emerging innovative suppliers or company/Department program managers, and implemented via Capability Area Reviews.

INDUSTRIAL BASE INVESTMENT FUND (IBIF): SETTING THE STAGE

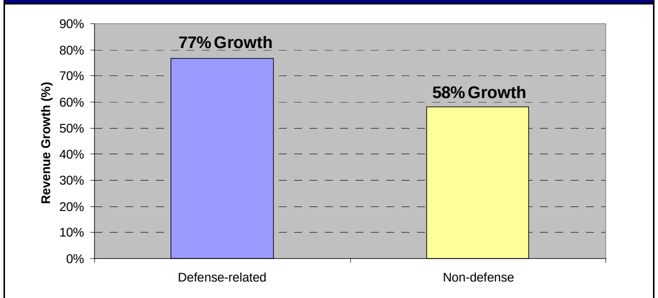
The ability of the Department to effectively source from the broadest industrial base available—and not just the traditional *defense* industrial base—will enhance innovation for future warfighters. For example, certain Protection warfighting capabilities increasingly will be provided by the commercial information technology industrial base[25] and other companies not traditionally associated with defense. *DIBCS FA* introduced the concept of an IBIF to identify leading edge technology of sufficient maturity to be inserted directly into programs of record. An IBIF, upon initiation, would function as a counterpart to Chairman's Innovation Funds common in corporate industrial settings, and be managed by the USD (AT&L). The Department is rapidly transforming the way it fights and the acquisition community is looking for new sources of innovation to meet warfighter needs. An IBIF would help bring such innovation to programs throughout their lifecycles.

Our February 2003 report, *Transforming the Defense Industrial Base: A Roadmap*, highlighted 24 emerging suppliers with innovative capabilities and identified barriers to entry these firms face in doing business with the Department. An IBIF presents an opportunity to provide ingress for some of these firms and other sources of innovation.

[25] This issue also was important to C2 warfighting capabilities. *DIBCS: Command & Control* identified ten critical industrial capabilities areas involving commercial IT in which the United States does not lead and must be willing to use non-U.S. commercial IT suppliers to achieve warfighting advantages. The use of commercial IT combines the low cost of a commercial product with defense-unique applications, creatively fusing defense-unique requirements and state-of-the-art commercial IT products. The Department must continue to strive to improve its ability to leverage commercial IT because its financial leverage over this global industry is so modest—only one percent ($28 billion) of annual global IT demand.

Of the 24 case study companies from the original study,[26] the study team revisited seven as part of *DIBCS: Protection*.[27] Generally, these companies have grown substantially in the last two years. Employment has grown on average from 860 to 1,200 employees (up 39 percent) and revenues have grown on average from $230 million to $366 million (up 59 percent). However, defense remains a relatively small business area for this group of predominantly commercial firms, representing only 5.5 percent of total revenues. That said, defense-related revenues grew 77 percent between 2002 and 2004—outpacing overall and commercial growth, as shown above.

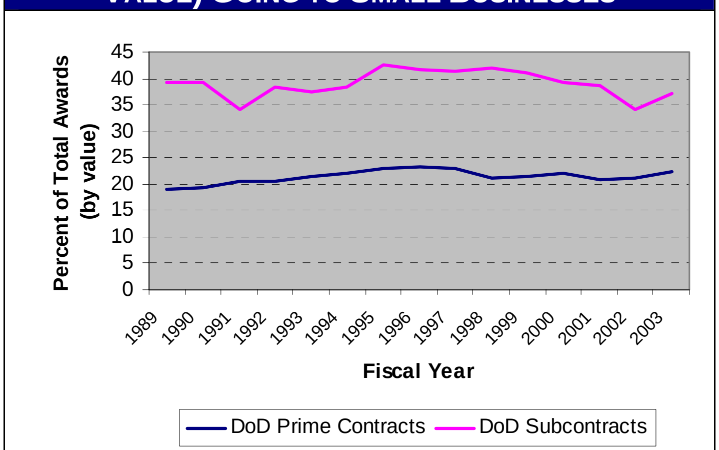
2002-2004 REVENUE GROWTH
SELECTED EMERGING DEFENSE FIRMS



Source: ODUSD (IP) Analysis

These statistics should give Department leaders pause for two reasons, both related to DoD contract awards to small businesses. First, the 21 percent growth rate in 2002-2003[28] small business prime contract awards appears low compared to the 70-80 percent defense revenue growth rate exhibited by the seven Protection case study companies. Second, the 8.5 percent growth rate in 2002-2003[29] small business subcontract awards lags the overall rate of growth of the seven case study companies revisited by an even larger margin.

PERCENTAGE OF DOD CONTRACT AWARDS (BY VALUE) GOING TO SMALL BUSINESSES



Source: Office of Small & Disadvantaged Business Utilization

Furthermore, in *DIBCS: Protection*, 35 percent of the companies assessed as providing relevant technology in priority critical technology areas had fewer than 100 employees.[30] If juxtaposed with the 22.4 percent of prime contracts awarded to small businesses[31] in FY03, it would seem that much

[26] See Appendix B of *Transforming the Defense Industrial Base: A Roadmap*, February 2003, for detailed case studies of these 24 companies.
[27] EluSys Therapeutics, Nomadics, Oakley, RSA Security, Systems Research & Development (SRD), Symantec, and Viisage.
[28] 3.3 percent compound annual growth rate, 1992-2002.
[29] Negative 1.2 percent compound annual growth rate, 1992-2002.
[30] Data from the *DIBCS BA, C2,* and *FA* industrial assessments is consistent.
[31] The definition of a small business varies by industry code. However, for some programs, like Small Business Innovation Research (SBIR) program, a company must be for-profit, U.S.-owned, independently operated, and U.S.-located; and must have 500 or fewer employees.

addressable innovation is being left on the cutting room floor. The fact that 37 percent of the value of FY03 DoD subcontract awards went to small businesses is admittedly more encouraging. All the same, as measured by growth rate, percentage of defense spending, or by the number of firms working in priority critical technology areas, the Department probably is not making full use of the innovation available in small emerging suppliers. Further, the overall U.S. economy is not benefiting fully from the major source of revenue and employment growth that small company innovation could generate.

IBIF Scope and Purpose

As first described in *DIBCS FA*, an IBIF would create an innovation investment vehicle at the most senior level of the Department's acquisition process to regularly insert real-time innovation in programs—from emerging and all available suppliers. If inserts from emerging suppliers grow to become the dominant source of an IBIF as forecasted, fund investments could provide a valuable additional path to market for these firms. In this way, an IBIF would augment current small business and technology transition/insertion initiatives.

The Industrial Base Investment Fund (IBIF)

An IBIF, upon initiation, would function as a counterpart to Chairman's Innovation Funds common in corporate industrial settings, and be managed by the USD (AT&L). It would aim to insert producible multi-application innovation in programs of record by funding integration, test, and initial procurement of candidate technology products. The fund would not take equity positions in companies.

Investments will be nominated by corporate sources of innovation and by the Program Managers/Program Executive Officers of the acquisition community. A formal nomination process and associated application materials will ensure consistency and a capabilities focus. An IBIF would be funded by Congressional appropriation. Fund guidelines to be generated later would provide asset allocation guidance relative to investment levels among the joint functional capability areas. There also would be restrictions relative to sources and uses of investments, so that no one nominating entity and no one program could dominate the fund at any given time.

All investment in any given fiscal year would be vetted by an Investment Advisory Board consisting of senior Department research, acquisition, and technology leaders. These investments would then be further vetted in the respective Program Managers Functional Capability Conference (PMFCC) prior to being submitted with other programmatic direction in the preliminary Acquisition Decision Memorandum (ADM) provided for the Capability Area Reviews (CARs).[a] It is anticipated that IBIF funding would grow from $20-30 million ($4-6 million per JFC) in its first year of operation to $100 million at full maturity.

[a] For further discussion of these set pieces of an enhanced acquisition oversight process under consideration, please see Appendix E.

Initiatives such as an IBIF are common throughout industrial and government settings. Many industrial enterprises have vehicles such as Chairman Innovation Funds intended to promulgate high-value technologies developed within a given corporate entity across a broad array of business opportunities. An IBIF would provide a similar vehicle

addressing *producible technology*[32] suitable for *programs of record* in a vehicle that ensures *broadest possible dissemination of innovation across all warfighting applications.*

> ***An Industrial Base Investment Fund would target:***
> - *producible technologies;*
> - *technologies easily inserted into programs of record; and*
> - *multiple, functional capability-based warfighting applications.*

The capabilities assessment and funding context an IBIF would provide is also unique and can be accomplished only at the level of the Department's capability acquisition oversight: the capability area reviews. Positioning an IBIF at this level would provide the greatest visibility across programs within a capability area and enable insertion into multiple warfighter applications. Situating an IBIF in a process that would provide it to all applicable Department programs and program managers has the further benefit of demonstrating to this community the Department's commitment to rapid, regular innovation—and, potentially, promote a cultural shift on the part of program managers to embrace technology insertion.

> ***"****If an Industrial Base Investment Fund could be structured to fund non-traditional and under-represented contractor communities, there would be benefit to the Department in terms of accessing technology and strengthening the industrial base. Through coordination with the acquisition and capability identification communities, an IBIF would identify and fund high impact technologies supported by capability needs, and transition those technologies to acquisition programs."*
>
> *- Red Team Member*

An IBIF would insert mature innovative technology into ongoing programs from the five sources shown to the right, thus acting as a single point of entry or portal for innovation. Other sources, such as investor proposals, may develop over time. However, in order to assure early momentum, program managers' nominations may be the primary investments of an IBIF in its initial years of operation. "Watch List" technologies could also provide early investment candidates.

Five Industrial Base Investment Fund Sources	
DoD	• ACTDs and/or Program Manager/Program Executive Officer nominations • "Watch List" technologies
Industry	• Innovative emerging firms • "Cutting room floor" innovative technologies from losing bids • Innovative technologies without available RFPs

Source: ODUSD (IP)

[32] Candidates could have a Technology Readiness Level (TRL) as low as a TRL 5, but would ideally be higher. Within the first year of funding, candidates would have to be able to demonstrate the equivalent of a TRL 9 and production readiness sufficient to meet rapid procurement requirements. See Appendix F for detailed treatment of Technology Readiness Levels.

Over the longer term, an IBIF would function to provide innovative emerging firms robust on-ramps into programs of record. While science and technology programs (such as Small Business Innovation Research, Small Business Technology Transfer and direct research and development contracts through DARPA and Service laboratories) help these companies develop technologies, migration into programs is difficult. Innovative technologies from losing bids or those without available bidding opportunities would also be sources of IBIF investments.

> *"Science and technology is a creative process that begins with exploration along many avenues. As technologies mature, some will succeed while others will fall by the wayside. Often, more ideas mature in the technology base than the acquisition community can absorb in development. An IBIF could provide a significant contribution by assisting technologies in transition from the technology community into acquisition. Opportunities might be found with technologies that can benefit several programs but are not "show stoppers" for any one program."*
>
> *- Red Team Member*

Several programs within the portfolio of the Deputy Under Secretary of Defense for Advanced Systems & Concepts (DUSD(AS&C)) transition innovative technology to the warfighter. However, no single program accepts nominations from all five IBIF sources mentioned on the previous page. Additionally, none of these programs or other Department technology transition/insertion programs are linked to the evolving PMFCC/CAR process. This linkage is a fundamental part of the IBIF concept; it provides visibility into technology insertion opportunities and a conduit to insert those technologies into acquisition programs. The Defense Acquisition Challenge Program (DACP), one of the Quick Reaction Special Projects (QRSP) initiatives, accepts nominations from industry, offering firms the opportunity to "challenge" incumbent positions on programs of record with capability-enhancing or cost-saving alternative products. DACP funds test and evaluation for selected submissions. With 580 proposals in FY05, the program has become a magnet for firms seeking a role on existing programs. The Technology Transition Initiative (TTI), also part of the QRSP, gives the Services, DoD agencies and SOCOM an opportunity to nominate innovative technologies developed by DoD laboratories or DARPA for accelerated insertion into programs. The Foreign Comparative Test (FCT) program funds testing to procure foreign technology products nominated by the Services and SOCOM. The most significant difference between an IBIF candidate and an Advanced Concept Technology Demonstration (ACTD) candidate is the direct, systematic self-nomination process (by industry or DoD acquisition managers) in a functional capability context. That is, the acquisition community "pulls" a technology

SELECTED PROGRAMS RESIDENT IN THE OFFICE OF THE DEPUTY UNDER SECRETARY OF DEFENSE FOR ADVANCED SYSTEMS & CONCEPTS (AS&C)

Selected AS&C Program	Description	FY05 Funding ($M)
Defense Acquisition Challenge Program (DACP)	Accelerates innovation from industry (emphasis on small firms) to programs of record, mapped to FCBs, funds integration and testing to procure	$21
Technology Transition Initiative (TTI)	Accelerates innovation from DoD Labs and DARPA to programs of record, mapped to FCBs, emphasis on Joint/multi-service candidates	$21
Foreign Comparative Test (FCT)	Accelerates foreign innovation nominated by the Services & SOCOM into programs of record, mapped to FCBs, funds testing and evaluation to procure	$36
Advanced Concept Technology Demonstration (ACTD)	Accelerates innovation to the field, new approach involves industry sponsorship aided by NDIA, COCOM endorsement/pull, focus on new systems/conops	$214

Source: ODUSD(AS&C) and Red Team Review

product into a program of record; an IBIF candidate does not require combatant commander sponsorship. The consolidation of these and other broad-based initiatives with an IBIF would quickly and efficiently transition near-production-ready technology into programs by raising visibility within the acquisition oversight process and providing better funding leverage.

An IBIF, over time, likely will provide innovative emerging firms—and the Department—an important vehicle not available in other vehicles or even through joint ventures with larger, more established defense firms.

Smaller companies' relationships with larger companies do not necessarily improve the Department's access to innovative companies. Sometimes larger companies can restrict DoD's access to smaller companies' innovation. First, based on their own strategic direction, prime contractors may not be motivated to advance innovation that may compete with in-house proprietary approaches. Second, prime contractors might choose to be more predatory, actively seeking to "buy and bury" innovative technology rather than risk disrupting a lucrative and potentially captured market position—a point verified through our research and reengagement with smaller, innovative emerging defense suppliers. Third, emerging suppliers might "pick the wrong horse" by aligning with larger firms whose programs are imperfectly aligned with their technology. From the perspective of the emerging defense supplier, this could be catastrophic, and certainly does not leverage the full value of their technology to the firm or to the warfighter.

From the Department's perspective, difficulties that emerging suppliers encounter when seeking to enter the Defense enterprise demonstrates a shortfall in Department processes and reduces DoD's breadth of awareness of possible solutions using innovative technology.

THE IBIF APPLICATION PROCESS

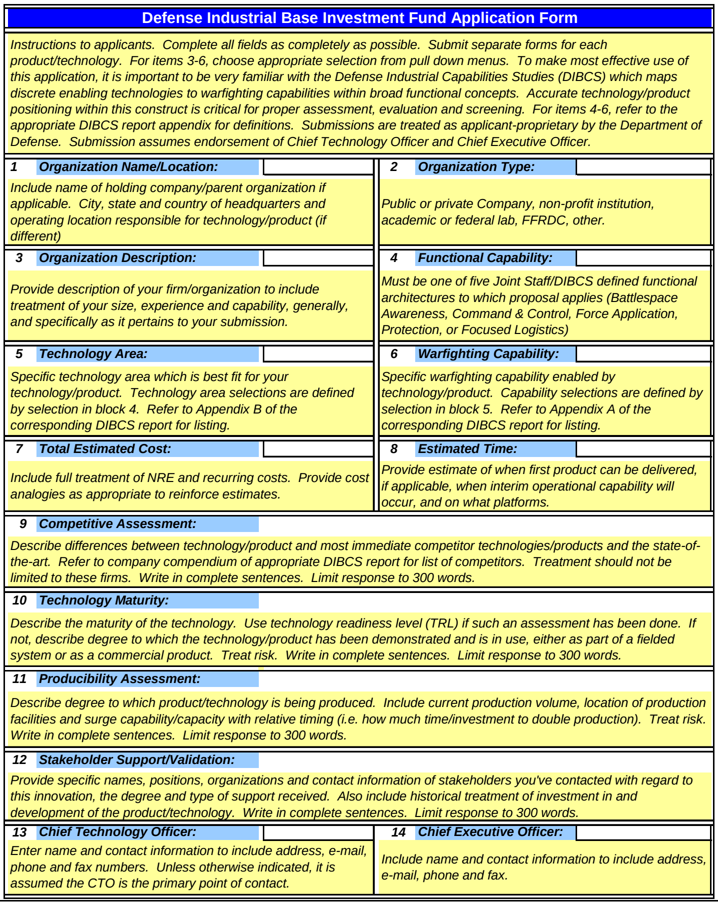
The application process envisioned provides an "end-to-end" link between industrial innovation and acquisition oversight conducted in a functional capability context.

The form shown on the next page provides a straightforward and standardized template with which applicants would describe their technology product using the Joint Staff's functional capability context.[33] It requires basic company and contact information (Parts 1 - 3), and then allows applicants to position nominated technology products based on the capabilities they provide (Parts 4 - 6). Specifically, in Part 4, the applicant indicates which functional capability(ies)[34] the product supports. In Parts 5 - 6, the applicant outlines the technology area that best describes the product and the warfighting

[33] See Appendix G for larger version of the form.
[34] Specifically, Battlespace Awareness, Command & Control, Force Application, Protection, and Focused Logistics.

capabilities the technology enables.[35] To complete Parts 4 - 6, applicants would vet their proposals in the context provided by the DIBCS series and the respective Appendices on warfighting capabilities and critical enabling technologies (Appendices A and B of each report). Parts 7 - 8 provide a cost estimate and anticipated time to complete the effort.

INDUSTRIAL BASE INVESTMENT FUND APPLICATION



Defense Industrial Base Investment Fund Application Form

Instructions to applicants. Complete all fields as completely as possible. Submit separate forms for each product/technology. For items 3-6, choose appropriate selection from pull down menus. To make most effective use of this application, it is important to be very familiar with the Defense Industrial Capabilities Studies (DIBCS) which maps discrete enabling technologies to warfighting capabilities within broad functional concepts. Accurate technology/product positioning within this construct is critical for proper assessment, evaluation and screening. For items 4-6, refer to the appropriate DIBCS report appendix for definitions. Submissions are treated as applicant-proprietary by the Department of Defense. Submission assumes endorsement of Chief Technology Officer and Chief Executive Officer.

1 **Organization Name/Location:** *Include name of holding company/parent organization if applicable. City, state and country of headquarters and operating location responsible for technology/product (if different)*	2 **Organization Type:** *Public or private Company, non-profit institution, academic or federal lab, FFRDC, other.*
3 **Organization Description:** *Provide description of your firm/organization to include treatment of your size, experience and capability, generally, and specifically as it pertains to your submission.*	4 **Functional Capability:** *Must be one of five Joint Staff/DIBCS defined functional architectures to which proposal applies (Battlespace Awareness, Command & Control, Force Application, Protection, or Focused Logistics)*
5 **Technology Area:** *Specific technology area which is best fit for your technology/product. Technology area selections are defined by selection in block 4. Refer to Appendix B of the corresponding DIBCS report for listing.*	6 **Warfighting Capability:** *Specific warfighting capability enabled by technology/product. Capability selections are defined by selection in block 5. Refer to Appendix A of the corresponding DIBCS report for listing.*
7 **Total Estimated Cost:** *Include full treatment of NRE and recurring costs. Provide cost analogies as appropriate to reinforce estimates.*	8 **Estimated Time:** *Provide estimate of when first product can be delivered, if applicable, when interim operational capability will occur, and on what platforms.*

9 **Competitive Assessment:** *Describe differences between technology/product and most immediate competitor technologies/products and the state-of-the-art. Refer to company compendium of appropriate DIBCS report for list of competitors. Treatment should not be limited to these firms. Write in complete sentences. Limit response to 300 words.*

10 **Technology Maturity:** *Describe the maturity of the technology. Use technology readiness level (TRL) if such an assessment has been done. If not, describe degree to which the technology/product has been demonstrated and is in use, either as part of a fielded system or as a commercial product. Treat risk. Write in complete sentences. Limit response to 300 words.*

11 **Producibility Assessment:** *Describe degree to which product/technology is being produced. Include current production volume, location of production facilities and surge capability/capacity with relative timing (i.e. how much time/investment to double production). Treat risk. Write in complete sentences. Limit response to 300 words.*

12 **Stakeholder Support/Validation:** *Provide specific names, positions, organizations and contact information of stakeholders you've contacted with regard to this innovation, the degree and type of support received. Also include historical treatment of investment in and development of the product/technology. Write in complete sentences. Limit response to 300 words.*

13 **Chief Technology Officer:** *Enter name and contact information to include address, e-mail, phone and fax numbers. Unless otherwise indicated, it is assumed the CTO is the primary point of contact.*	14 **Chief Executive Officer:** *Include name and contact information to include address, e-mail, phone and fax.*

Source: ODUSD (IP)

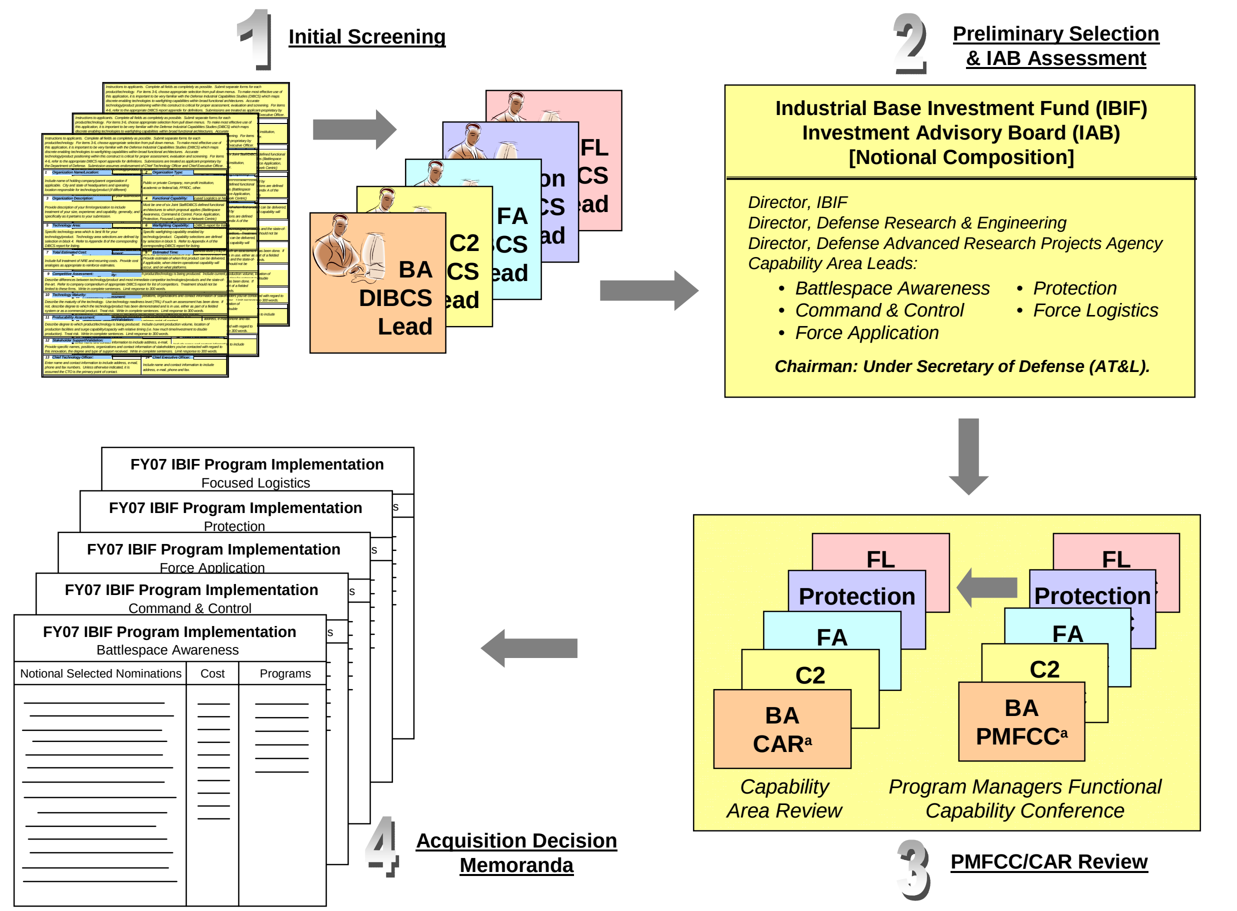
The competitive assessment requested in Part 9 gives the applicant an opportunity to differentiate its product from peer offerings—once again, leveraging the competitor context provided in the Compendium Appendix of each DIBCS report (Appendix C). Part 10 helps reviewers determine if the product is sufficiently mature to qualify for IBIF funding. The producibility assessment requested in Part 11 augments the assessment of maturity by addressing production readiness. In Part 12, applicants describe communications they have had with, and support received from, Department offices and potential customers so that the Department can assess bona fides already established. Parts 13 and 14 require Chief Technology Officer or Chief Executive Officer endorsement to ensure validity and to aid in the prioritization and vetting within corporate entities of IBIF candidates.

Taken in total, the application information will allow IBIF reviewers to effectively vet applications and refer immature products, or those otherwise not suitable for IBIF but of potential interest, to the appropriate DoD activity. Qualified submissions would then proceed through the process discussed in detail over the next several pages, outlined in four basic steps. Applicants will be engaged, as necessary, to obtain supplemental information.

The chart on the next page shows how the application would be evaluated within the context of the Department's acquisition process to insert qualifying technologies/ products into acquisition programs.

[35] See Appendix A for list of warfighting capabilities constituting the Protection functional capability, and Appendix B for list of the most critical technologies supporting *BA/BWA* technologies.

THE INDUSTRIAL BASE INVESTMENT FUND APPLICATION AND IMPLEMENTATION PROCESS



[a] For further discussion of these set pieces of an enhanced acquisition oversight process under consideration, please see Appendix E.

Source: ODUSD (IP)

1. Initial Screening. The DIBCS leads would provide initial screening. On a rolling basis, the DIBCS leads would review applications working closely with SMEs within the OUSD (AT&L), Services, and Joint Staff. The DIBCS leads may reject a proposal outright, refer viable candidates to the IBIF Director, or direct candidate products not mature enough for consideration or more appropriately addressed by another DoD program to the relevant DoD point of contact. Thus, the IBIF also would function as an innovation clearinghouse within the Department.

2. Preliminary Selection and IAB Assessment. On an annual basis, correlated to the PMFCC/CAR[36] cycle, the IBIF Director would present the most promising candidates to the IBIF Investment Advisory Board (IAB), after conducting a cross-functional review. The IAB would include senior Department experts from DDR&E, DARPA,

[36] For further discussion of these set pieces of an enhanced acquisition oversight process under consideration, please see Appendix E.

and other OUSD (AT&L) staff. The IAB would assess the candidates using criteria similar to those used in the DIBCS technology prioritization process. The DIBCS prioritization process gives heaviest weight to breakthrough technologies supporting *BA/BWA* capabilities and those technologies with the broadest span of impact across multiple programs and applications.

3. PMFCC/CAR Review. The IAB would forward the most promising candidates to the PMFCC/CAR leads for further assessment and funding consideration within the annual CAR cycle. Appendix E contains a complete description of the PMFCC/CAR process.

> ***"****Having the annual Capability Area Review (CAR) process select the most promising technologies for insertion into ongoing programs represents but one of the many benefits of carrying out regular, functional capability-oriented assessments as part of the revised acquisition oversight process. These annual reviews, which will focus on a selected aspect of a functional capability area, will also facilitate collaboration among senior acquisition decision-makers and program managers. Such recurring collaboration will facilitate the sharing of lessons learned about effective management tools and techniques, and technological breakthroughs. It will cultivate a "community of knowledge" among key players involved in a particular joint functional capability area. In addition, insights that bridge the functional areas will be pollinated across the acquisition community by CAR champions, magnifying the benefits of the CAR process."*
>
> *- Red Team Member*

4. Acquisition Decision Memoranda (ADMs). The ADMs produced by the respective CARs would provide guidance and direct funding to insert selected technologies/products into specific programs. In this way, the IBIF would be similar to a Chairman's Innovation Fund in private industry, allowing the most senior DoD acquisition officials to directly influence the insertion of critical, near-production-ready technologies into key defense programs.

IBIF Process Example

Massachusetts-based Viisage's PROOF™ provides an example of how an IBIF process would work. PROOF enables numerous BA/BWA capabilities to protect against threats such as unauthorized access, false identification, and spoofing of user and authentication mechanisms. PROOF™ has potential to enable warfighting capabilities in the JFC areas of Protection and Battlespace Awareness.

The DIBCS leads for the Protection and Battlespace Awareness functional concept areas would jointly evaluate product maturity, capabilities, and programmatic span of impact. They would do this in consultation with SMEs from the Office of the Assistant Secretary of Defense for Networks and Information Integration (NII), the Joint Staff, and the Services.

Based on this collaborative analysis, the IBIF Director would forward the candidate to the IAB. If approved, the IAB would recommend PROOF™ to the Protection and Battlespace Awareness PMFCC/CAR leads for subsequent PMFCC/CAR deliberations—and, ultimately, integration into the ADM(s) for IBIF funding.

In the first year, funding to insert approved technologies would be provided to respective program managers at funding levels agreed to in the PMFCC and the CAR. Program managers could petition for additional funding in the following PMFCC/CAR cycle. The IAB would determine if second- or third-year funding would be necessary. After the third year, the program manager would be expected to provide any required additional funding, including operational test and evaluation and life cycle requirements. The IBIF Director and IAB would track results of the IBIF investments annually through the PMFCC/CAR process.

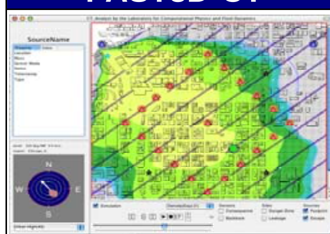
Potential IBIF Candidate Examples[38]

DoD IBIF Nominations

As identified earlier, IBIF candidates may be nominated from several sources within the Department of Defense. Department sources include Program Managers (PMs), Program Executive Officers (PEOs), and DIBCS "Watch Lists." Program managers are focused on cost, schedule, and performance and therefore may be hesitant about inserting innovative products that could impact program execution. As a result, innovation is often left on the sidelines. The IBIF presents an opportunity to help program managers insert high value-added technology into their programs, while mitigating impact to established baselines. Examples of PM/PEO nominations follow.

The Joint Program Executive Office for Chemical Biological Defense has nominated an IBIF candidate within Protection's "Consequence Management" JFC capability area. It enables *BA* warfighting capabilities to contain and control the drift of biological aerosols and chemical vapors by analyzing and tracking plumes. Naval Research Laboratory's CT-Analyst® (a near-instantaneous plume prediction system) and FAST3D-CT (a 3-D computational model) together would support site disaster response planning and execution, civilian and military training, and sensor network optimization. IBIF funding could accelerate technology transition to the warfighter by 18 to 24 months. The IBIF would fund development and independent verification and validation of this TRL 6 technology, and would lead to qualification for several applications within the next 12 months instead of three to four years. This accelerated development would have significant payoffs for Chemical Biological Defense programs, such as the Guardian Program, and possibly Ballistic Missile Defense program.

Chem-Bio Defense Example: CT-Analyst® & FAST3D-CT



- Enables "Consequence Management"
- Offers near-instantaneous plume prediction and disaster response modeling
- IBIF would fund development and independent verification and validation; and accelerate transition to warfighter by 18-24 months

---

[38] Mention of specific companies and products in this report does not imply future business opportunities with or endorsement by DoD. IBIF activities will be in compliance with all federal and defense acquisition regulations and policy guidelines.

CHEM DEMIL EXAMPLE: OMNIEYE CERBERUS™

- Enables "Passive Defense"
- Offers multi-spectral and dimensional surveillance that significantly increases capability to secure critical infrastructure
- IBIF would fund technology demonstration for insertion across a wide array of applications

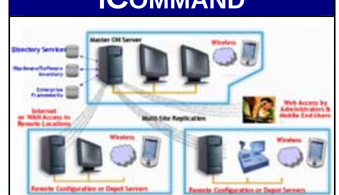
The Joint Program Office for Chemical Demilitarization nominated an IBIF candidate within Protection's "Passive Defense" JFC capability area. It provides passive asset level protection of fixed and non-fixed infrastructure, and potentially has application within the Battlespace Awareness JFC. OmniEye Cerberus™, made by Genex, would help secure chemical weapons storage sites. OmniEye Cerberus™ is a reconfigurable multi-sensor system for long distance infrared and visible detection, leveraging commercial off-the-shelf (COTS) components. It can employ multiple layers of sensors such as infrared, near-infrared, image intensified, midwave infrared, shortwave infrared, and visible sensors. IBIF funding would directly support demonstration of this production-ready technology for fixed infrastructure applications. IBIF funding would provide the additional benefit of demonstrating viability for other installation and infrastructure protection situations. For example, the Navy could use the sensor as a surveillance node for port and cargo container vessel security and the Army could integrate it with unmanned surface vehicles for multi-spectral remote reconnaissance missions supporting Battlespace Awareness.

INDUSTRY IBIF NOMINATIONS

As identified earlier, industry sources also could nominate IBIF candidates. Industry candidates could include technologies without identified DoD requirements or current requests for proposal (RFPs); technologies developed as part of losing bids that could be picked up for integration into programs of record; and/or technologies offered by emerging defense suppliers having difficulty finding a path to market. Continuing visits to emerging defense suppliers have reinforced the value of an IBIF to industry. Indeed, several suppliers provided examples of potential candidates.

Symantec nominated an IBIF candidate within Protection's "Active Defense" JFC capability area. It enables *BA/BWA* warfighting capabilities such as active protection from hackers, active protection from computer network exploitation, and active protection from denial of service/access. Such capabilities are unlikely to Symantec's iCommand Enterprise product could augment and synergize current approaches to this challenge in programs such as security and vulnerability management, early warning, threat identification and virus protection for any programs that use the Global Information Grid. IBIF funding would be used to evaluate and acquire the iCommand Enterprise and—if warranted—assess relevance to *BA/BWA* capabilities in other functional concepts.

SYMANTEC EXAMPLE: ICOMMAND



- Enables "Active Defense"
- Provides network centric enterprise control; could eliminate security and asset management problems
- IBIF would fund acquisition

SRD EXAMPLE: NON-OBVIOUS RELATIONSHIP AWARENESS™

NORA

- Enables Battlespace Awareness – "Observe and Collect Information Worldwide" and "Analysis of Intelligence Information"
- Provides non-obvious relationship awareness with up to 30 degrees of separation
- IBIF funding would support acquisition and enterprise-level integration

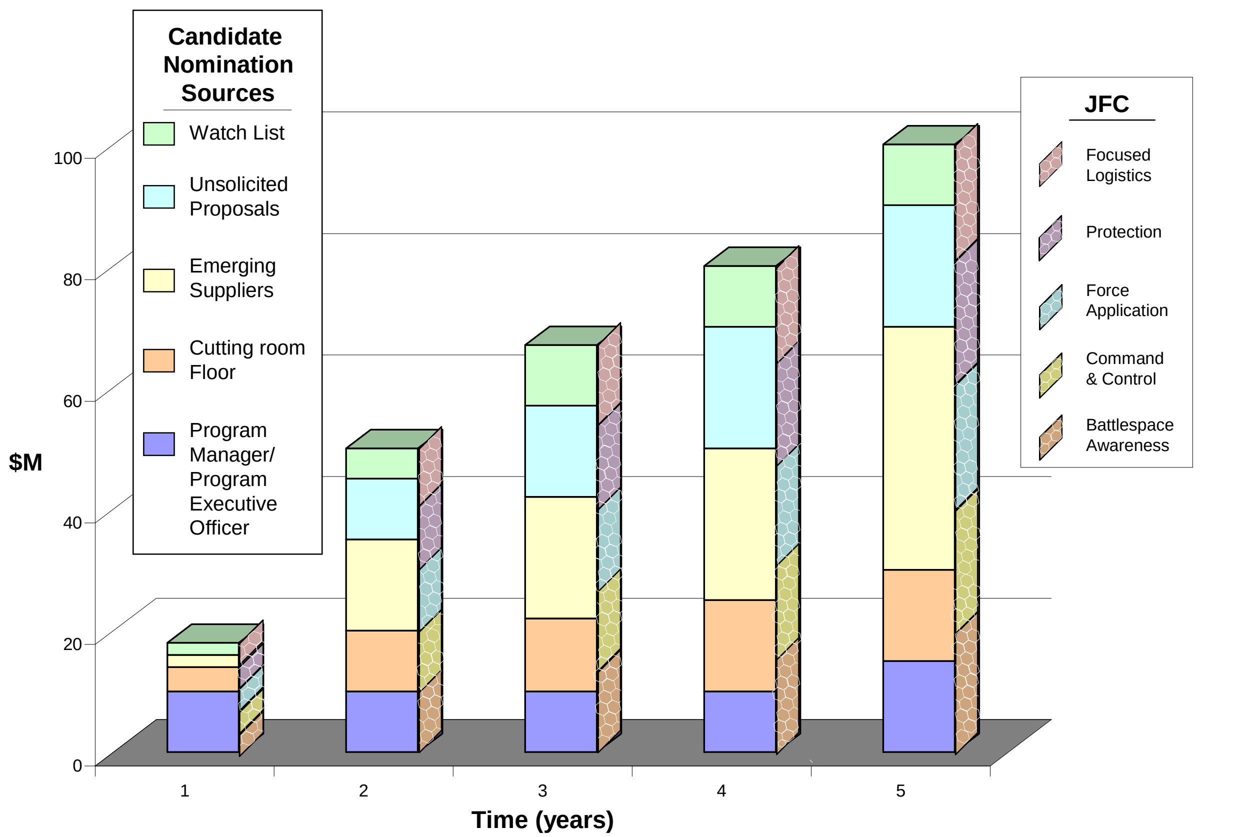
SRD nominated an IBIF candidate within the Battlespace Awareness JFC capability areas of "Observe and Collect Information Worldwide" and "Analysis of Intelligence Information." It enables *BA/BWA* warfighting capabilities such as exploiting intelligence, surveillance, and reconnaissance to influence planning, fuse multiple information sources, and characterize emerging threats. SRD's Non-Obvious Relationship Awareness (NORA™) analyzes terabytes of information to identify relationships among data points, providing services such as modeling of adversary behavior, dynamic data base fusion, and intelligence awareness with up to 30 degrees separation. ANNA™ offers the same capabilities as NORA™ but with data anonymity via pre-analysis encryption and post-analysis decryption. IBIF funding would allow for rapid acquisition, tailoring for specific applications, and adaptation for enterprise-level integration.

In summary, examples abound of technology products enabling *BA/BWA* capabilities needed by the warfighter, many with potential value across JFCs. What is lacking is a senior-management mechanism to rapidly identify, adapt, and acquire innovative, near-production-ready technologies for programs of record. An IBIF could provide this capability—and improve the responsiveness of the acquisition system to operational needs.

OPERATIONAL PREVIEW OF THE FUND

The table below provides a notional preview of the IBIF's first five years of operation. It illustrates funding objectives, candidate nomination sources, and distribution among JFCs. It assumes Congress appropriates the necessary funding.

THE INDUSTRIAL BASE INVESTMENT FUND: A NOTIONAL OPERATIONAL PREVIEW



Note: The side of each three-dimensional bar is divided into five equal segments representing how the IBIF could be split among the five functional capability areas. There is no intended correlation to the face of the bar which delineates the sources of candidate nominations.

Source: ODUSD (IP)

In its first year of operation, the fund likely would not exceed $20-30 million and PM/PEO-nominated investments would dominate the fund. As the fund grows to full maturity, it would provide sturdy on-ramps for sources of innovation that often are waylaid by the Department's acquisition processes. These sources would include innovative firms without strong footholds in the defense enterprise, valuable technologies salvaged from losing bid proposals, and those technologies without contracting opportunities but viewed as synergistic with multiple programs of record.

The study team previewed the IBIF concept with several emerging firms and legacy defense suppliers, and it was received with great enthusiasm. Emerging defense suppliers view it as a viable avenue to market, providing them a champion for innovation

accessing Department resources and decision-making capabilities at the most senior levels. Prime contractors see it as a vehicle to get a more capable product to the warfighter and to be more responsive to the customer and national security needs.

For the acquisition community, an IBIF would provide an innovation insertion vehicle of last resort. Its link to Department oversight and budgeting processes, and the resulting direct links to program funding, would increase IBIF effectiveness. The Department will greatly accelerate innovation enabling *BA/BWA* warfighter capabilities, if this concept is institutionalized and proves successful. Further, through its responsiveness and agility, the IBIF could promote a cultural change within the acquisition community to embrace technology insertion.

An IBIF would reinforce the Department's aim to foster myriad sources of innovation for high priority technologies in emerging companies, thus broadening the industrial base from which the Department draws technical solutions. An IBIF could provide funding streams for smaller companies, now often available only through merger and acquisition transactions. An IBIF also could leverage investment in innovative suppliers from financial and corporate investors. Better yet, such investors may attempt to anticipate IBIF investments in order to invest first for higher returns.

The Department finds itself at an important juncture with an opportunity to make a revolutionary improvement to meet warfighter needs. By leveraging broader acquisition process and oversight changes within the functional capabilities construct, the Department is positioned to increase the efficiency, speed, and effectiveness with which it inserts technology from all defense firms into programs. With an IBIF, the Department can address the "valley of death" between technology innovation and product acquisition in a new and effective way. It leverages the top-level, capabilities-based perspective of the USD (AT&L) to affect broad, high-impact insertions of technology to the benefit of the warfighter.

PART IV

POLICY REMEDIES FOR PROTECTION INDUSTRIAL BASE ISSUES

The Department has a number of internal and external tools with which the Under Secretary of Defense (Acquisition, Technology and Logistics) can develop remedies to support the development, fielding, and continued improvement of the industrial base supporting Protection. They are: technology innovation investments; optimization of acquisition strategies; and Hart-Scott-Rodino (HSR) anti-trust and Committee on Foreign Investment in the United States (CFIUS) national security review process remedies. The "Watch List" and IBIF represent other tools developed as part of the DIBCS series designed to strengthen the industrial base. This assessment of PJFC priority critical technologies and associated industrial capabilities identified seven industrial base sufficiency issues and two "Watch List" items, for which remedies are proposed. The DIBCS series assessments will continue to examine industrial base sufficiency and uncover additional issues. Appropriate remedies for those issues will be considered at that time.

As discussed earlier, 55 of the 64 priority critical technologies and their associated components are sufficient to meet future requirements. While some of the technologies are still in development, an adequate supplier base is likely to develop because a sufficient number of U.S. industry and research institutions lead in technology.

ISSUES IN THE PROTECTION INDUSTRIAL BASE

The industrial base for the seven technologies shown in the table on the next page is insufficient. Four of the seven technologies are still in the R&D phase (TRL 8 or below), providing ample opportunity to make appropriate investments through structured competitions that can strengthen the industrial base. The remaining three are in the production phase (TRL 9). In all three cases U.S. leadership is *Even* with foreign suppliers, but the study team identified only two U.S. suppliers working in each technology area.[39]

<u>Non-Lethal Millimeter Wave Active Denial System</u>. The Active Denial System (ADS) is a breakthrough non-lethal technology that uses millimeter-wave electromagnetic energy to stop, deter, and turn back an advancing adversary from relatively long range. The United States appears to be the only source of this type of technology and application. At this time, ADS technology is being developed exclusively for military use. The Services should continue to fund innovation, seek new military applications, and broaden the industrial base by conducting development competitions to advance the technology. These competitions should be structured to foster the entry of additional sources. The Department needs to closely monitor the development of this industrial base (including via HSR and CFIUS reviews) and control the export of this technology.

---

[39] U.S. technology leadership is characterized by the terms *Leads, Even,* and *Trails* as compared to non-U.S. suppliers.

PROTECTION INDUSTRIAL BASE ISSUES							
Technologies	**Industrial Base Sufficiency**				**Policy Levers**		
	Technology Readiness Level (TRL)	**Domestic Sources**	**Foreign Sources**		**Fund Innovation**	**Optimize PM Structure & Acq Strategy**	**External Corrective Measures**
Non-Lethal Millimeter Wave Active Denial System	TRL 7	1	0		Invest R&D in additional sources to broaden industrial base and gain sponsorship.	Services conduct competitions to foster the entry of additional sources.	Consider for Militarily Critical Technology List. Monitor potential consolidation via HSR/CFIUS.
30-mm Supercavitating – Supersonic Projectiles	TRL 6	3	1[40]		Invest in R&D to establish U.S. technology leadership.	Conduct defense system design competitions for this technology.	Deny teaming arrangements and transactions that limit innovation; sustain sufficient suppliers.
Multi-Spectral Camouflage Cover	TRL 9	2	>3		Invest in R&D for next-generation camouflage; and to improve surveillance capabilities to defeat current camouflage.	Structure R&D investments to encourage competition and broaden the industrial base.	Monitor future foreign acquisition of U.S. suppliers. Monitor export control.
Regenerative Chemical-Biological Filtration	TRL 8	1	3		Fund development of additional U.S. sources.	Conduct defense system design competitions for this technology.	Deny teaming arrangements that limit innovation.
Plasma Antenna	TRL 6	3	3		Fund innovation to establish U.S. lead and adapt technology for additional applications.	Conduct defense system design competitions for this technology.	Deny teaming arrangements that limit innovation. Monitor export control.
Active Magnetic Signature Reduction System	TRL 9	2	>3		Invest in R&D to develop new U.S. suppliers, establish U.S. technology leadership, and improve sensors to defeat this technology.	Conduct defense system design competitions for this technology.	Deny teaming arrangements and transactions that limit competition. Monitor export control.
Thermo-Insulating Paint for Low Observable Hullforms	TRL 9	2	1		U.S. Navy should fund innovation to develop next-generation technological solution and U.S. sources.	U.S. Navy conduct defense system design competitions for next-generation technological solutions.	Deny teaming arrangements and transactions that limit competition. Monitor export control.
Source: Booz Allen Hamilton and ODUSD (IP)							

<u>30-mm Supercavitating-Supersonic Projectiles</u>. This technology provides surface or air launched projectiles with enhanced water entry, underwater speed, and depth of effective penetration for use against mines, underwater vehicles, and swimmers. The

[40] Russia, France, Ukraine, and China may be working in this technology area. However, the limited publicly available information identified only one French research facility.

30-mm technology is expected to be deployed on the U.S. Marines Expeditionary Fighting Vehicle—formerly the Advanced Amphibious Assault Vehicle. Supercavitatiing technology is a breakthrough technology in the United States. However, at least one French research facility is working in this area and Russia has over twenty years of operational experience with supercavitating weapons. Thus, the U.S. technology is rated *Even* with foreign countries. The Department should work through the Navy to fund investments in research and development to expand Protection applications and build U.S. technology leadership. The Department also should consider conducting weapon system design competitions to sustain a sufficient number of suppliers. The Department needs to closely monitor the development of this industrial base (including via HSR and CFIUS reviews) and control the export of this technology. Given the breakthrough, potentially disruptive nature of this technology, the Department also should closely monitor foreign advances.

Multi-Spectral Camouflage Cover. Multi-spectral camouflage covers provide protection to equipment, vehicles, and personnel from a variety of sensing technologies. This technology is currently in production by several companies worldwide. The study team assessed the United States as *Even* with foreign technology. There are only two U.S. providers and numerous foreign providers. Multiple European companies appear to have market-leading technology. This is a mature technology, at a TRL 9, with incremental improvements ongoing but no major leaps foreseen. The major European suppliers sell to militaries and governments worldwide, including the U.S. military and its potential adversaries. While one of the foreign suppliers most advanced in this technology is Saab AB and its U.S. based subsidiary, Saab Barracuda LLC, the proliferation of these products remains of concern. Their ability to defeat U.S. military surveillance is also a concern. However, multi-spectral camouflage cover technology is mature and there are at least two U.S.-located sources of supply. Therefore, the Department should focus research and development activities on revolutionary next-generation camouflage technologies and on improving surveillance capabilities (a Battlespace Awareness warfighting capability) to defeat state-of-the-art camouflage technologies.[41] The Department also should monitor any future foreign acquisition of U.S. suppliers.[42] Finally, the United States should control U.S. exports and the Department should monitor foreign export of this technology.

Regenerative Chemical-Biological Filtration. This important Protection technology allows military vehicles and structures to provide long-lasting filtration with much less frequent replacement than is required with traditional carbon filters. This represents a new way of providing chemical-biological protection, requiring less logistics support. Only one U.S. developer was identified for this technology, in addition to one military research lab. The U.K. appears to hold a lead in this technology. The U.K. is both

[41] This issue highlights a nuance in DIBCS leadership goals. In this case, U.S. warfighting superiority is not based only on developing revolutionary camouflage technologies (a Protection capability) but on defeating a potential adversary's state-of-the-art camouflage capabilities (a Battlespace Awareness capability). This issue also demonstrates the relationships among functional concepts and therefore among the DIBCS reports.

[42] Saab Barracuda acquired the camouflage business of BAE Systems Integrated Defense Systems, Inc., a U.S.-located subsidiary of BAE North America. Reference CFIUS case page 23.

supplying, and conducting R&D for, the U.S. military. This is currently a limited market, but it has the potential to grow for both military and non-military applications. The Department should fund innovation cooperatively with the U.K. to advance the technology and to establish potential new U.S. suppliers. It also should consider structuring competitive opportunities for this technology in relevant system designs. The Department should seek to deny teaming arrangements that limit innovation and monitor export control.

Plasma Antenna. These devices are light, compact, rapidly reconfigurable antennas that are difficult to detect and resistant to countermeasures. Plasma antennas are a fundamental change from the traditional antenna design that generally employs solid metal wires as the conducting element. This potentially disruptive technology has numerous military and civilian applications. The Department should provide additional R&D funding to build technology leadership and adapt the technology for additional applications. The Department also should create competitive opportunities for weapon system designs. Additionally, the Department should closely monitor teaming arrangements and corporate acquisitions to ensure competition and innovation. Finally, the United States should control U.S. exports and the Department should monitor foreign exports.

Active Magnetic Signature Reduction System. This technology dynamically compensates to nullify magnetic signatures caused by metallic objects or their motion through the natural environment. The active suppression of magnetic signatures is a mature technology, intended to protect against high- and low-technology magnetic detection systems. Improvements to this technology are likely to come as advancements in the real-time magnetic field measurement systems, which feed into the active magnetic signature reduction systems. The Department should invest in additional R&D to develop new U.S. suppliers and establish U.S. technology leadership and to improve sensor technology to counter this technology. The Department also should conduct system design competitions to provide innovation and broaden the supplier base. The Department should closely monitor teaming arrangements and corporate acquisitions to ensure competition and innovation. Finally, the United States should control U.S. exports and the Department should monitor foreign exports.

Thermo-Insulating Paint for Low-Observable Hullforms. This technology effectively decreases a ship’s temperature signature to help avoid infrared detection by enemy forces. No country has a clear advantage in the development of thermo-insulating paint technologies. Investments in advancing this technology likely would lead only to minimal improvements. Therefore, the U.S. Navy should provide R&D funding to develop the next-generation technological solution. The U.S. Navy should conduct defense system design competitions to broaden the supplier base. As with other critical technologies, the Department should monitor teaming arrangements and corporate acquisitions to ensure competition and innovation. Finally, the United States should control U.S. exports and the Department should monitor foreign exports.

THE PROTECTION "WATCH LIST"

This Protection assessment identified two unique technologies for key warfighting capabilities, which should be monitored by the Department. These "Watch List" items are discussed in the chart below.

PROTECTION INDUSTRIAL BASE "WATCH LIST" ITEMS

Technologies	Industrial Base Sufficiency				Policy Levers		
	Technology Readiness Level (TRL)	**Domestic Sources**	**Foreign Sources**		**Fund Innovation**	**Optimize PM Structure & Acq Strategy**	**External Corrective Measures**
Towed Fabric Balloon Pressure Sweep	TRL 6	0	1		Navy consider R&D investment and/or invest in alternative technologies to defeat pressure mines.	Assess Navy sponsorship. Consider as foreign cooperative program, FCT, or potential IBIF candidate.	Monitor proliferation.
Rigid Polyurethane Foam (RPF)	TRL 6	100s	Many		Protection FCB consider sponsorship of ACTD.	Consider conducting system design competitions for this technology.	Monitor for foreign military applications which would require U.S. countermeasures.

Sources: ODUSD (IP) and Booz Allen Hamilton

Towed Fabric Balloon Pressure Sweep. As mentioned in Part II, R&D for this potentially disruptive technology is being spearheaded by the Australian Defense Science and Technology Organization, with prototype components made by an Australian firm. This is a technology the United States should monitor and consider supporting if it bears fruit. The United States likely can leverage the Australian work in a foreign cooperative or test program. The Navy PEO for surface warfare should consider sponsoring this technology as a candidate for the Foreign Comparative Test (FCT) program. An IBIF could also fund this technology. The Department then could conduct competitions to further develop the technology and broaden the supplier base. The United States may also want to invest in alternative technologies to develop new approaches to defeating pressure mines.

Rigid Polyurethane Foam (RPF). RPF technology has a multitude of potential military applications: countermine protection, foam road surfaces, personnel walkways through minefields—though few are being exploited. The vast majority of the market is in commercial applications including insulation, building materials, and consumer products. The study team assessed U.S. technology leadership as *Even* with foreign development. The lack of military exploitation of this potentially disruptive technology merits further investigation, and action should be taken to encourage development, if warranted. The study team recommends that the Protection Functional Capability Board consider identifying potential applications for consideration as an ACTD. The

Department should monitor foreign military applications of this technology which would require U.S. countermeasures.

In addition to these specific remedies, the DIBCS assessments to date have confirmed the soundness of this methodology and the importance of ODUSD (IP)'s role as the clearinghouse for industrial base deficiencies. ODUSD (IP) should continue to be the clearinghouse and further assess industrial base sufficiency using the DIBCS series capabilities framework, databases, and policy tools.

For other defense industrial base issues and assessments, ODUSD (IP) maintains insight into Service, Defense Agency, other Department, and interagency industrial base activities in its day-to-day responsibilities. This role is Congressionally-mandated in its responsibility for preparing the *Annual Industrial Capabilities Report to Congress*.[43] In addition, in the interagency process, ODUSD (IP) coordinates on all industrial base issues affecting the Department. For all of these reasons, ODUSD (IP) is uniquely positioned and qualified to serve in this capacity.

The Department should continue to evaluate Protection *BA/BWA* warfighting capabilities, the technologies that enable them, and associated industrial base. The Department should employ funding vehicles such as an IBIF, focused acquisition strategies, and internal and external policy levers to remedy the seven identified industrial base issues. The Department also should monitor "Watch List" items and be prepared to address them. The DIBCS series has identified tools to maximize competition and innovation. Applying the tools with diligence will greatly increase confidence that priority critical technologies and associated industrial base capabilities are available when needed to maintain U.S. warfighting superiority over any potential adversary.

[43] See Section 2504 of Title 10, United States Code.

AFTERWORD

Defense Industrial Base Capabilities Study: Protection is the fourth of a five-part series which assesses the ability of the industrial base to produce the technologies and components most critical for 21st century American warfare as defined by the Joint Staff's functional concepts.[44] The first three studies—Battlespace Awareness, Command and Control,[45] and Force Application—were published in January, June, and October 2004, respectively.[46] Focused Logistics will complete the series in mid-2005.

The first study in this series, *Defense Industrial Base Capabilities Study: Battlespace Awareness (DIBCS BA*), was generated against the backdrop of "Buy American" legislation that did not take into account the positive impact that non-U.S. suppliers can have on U.S. warfighting. It's important to note that non-U.S. suppliers have and will continue to play a role in the industrial base supporting the Department. The *DIBCS: Protection* study highlighted two examples where heretofore foreign suppliers play a key role in important warfighting capabilities, and where associated foreign direct investment in U.S. production capabilities have had significant positive economic and employment impact in local American communities.

For example, DoD body armor requirements increased greatly prior to combat operations in Afghanistan and Iraq, straining domestic industry's ability to meet DoD warfighting requirements, especially for the specialized ballistic backing material incorporated into the body armor. Between April 2002 and May 2003, DoD's monthly requirements for the backing material quadrupled and the sole domestic source—Honeywell—was unable to keep up with the demand. Although not completed in time to support initial operations in Iraq, Dutch State Mines (headquartered in the Netherlands) built a new production facility for a comparable backing material in Greenville, NC, significantly increasing domestic production capacity. This increased capacity is absolutely essential as DoD requirements continue to grow and can be met only with both suppliers operating at full capacity.

In another example, Saab (headquartered in Sweden) was an early leader in the development of protective camouflage covering materials. Saab licensed this technology to Tracor in 1995. Marconi acquired Tracor in 1999. BAE Systems acquired Marconi in 2000. In recognition of the importance of this technology—even before the DIBCS series identified it—Saab purchased the BAE Systems unit producing this technology in April 2002. Saab expanded this facility by an additional 22,000 square

[44] See Chairman of the Joint Chiefs of Staff's Joint Capabilities and Integration Development System (JCIDS), CJCSI 3170.01D (February 2004), specifically the functional concepts—Battlespace Awareness, Command and Control, Force Application, Protection, Focused Logistics—where we assessed materiel industrial base capabilities to be most relevant.

[45] The Joint Staff has developed an additional functional concept, Network Centric Operations (NCO). The *DIBCS C2* report published in June 2004 included capabilities relevant to that functional concept. As the NCO functional concept is finalized, ODUSD (IP) will review the DIBCS series to ensure NCO industrial base capabilities are appropriately considered.

[46] These reports can be viewed online and downloaded at http://www.acq.osd.mil/ip.

feet, adding 132 jobs (more than doubling its employment) in the Lillington, NC, community and increasing revenues generated for the local tax base in this community from about $18 million in 2002 to an estimated $54 million in 2004.

Examples such as these are a small manifestation of recent positive trends in foreign direct investment in the U.S. defense and aerospace sector. Overall foreign direct investment[47] in the United States declined by 12 percent from the 1996-1999 to the 2000-2003 period. However, foreign direct investment in the U.S. defense and aerospace sector dramatically increased, nearly tripling over the same period, as shown in the table below.[48] Such investments increase U.S. employment, create higher paying jobs, and increase tax revenues.

FOREIGN DIRECT INVESTMENT IN THE U.S.— CUMULATIVE FLOW
(MILLIONS OF CURRENT DOLLARS)

Foreign Direct Investment in the United States -- Annual Flow

	1992-1995	1996-1999	2000-2003
Overall			
Volume	$173,752	$645,663	$566,110
% Change		272%	-12%
Aerospace			
Volume	$894	$1,158	$3,448
% Change		30%	198%

Source: U.S. Department of Commerce, Bureau of Economic Analysis, Aerospace data drawn from NAICS 3364 (Aerospace Product & Part Manufacturing, which includes aircraft, engine, missile, and space systems and parts and auxiliary equipment manufacturing).

Furthermore, foreign-based suppliers in the Protection functional capability area may be able to offer compelling, best-value products, particularly for the 30 percent of warfighting capabilities for which there is no imperative for the Department to have a lead over potential adversaries. It is important that the United States invest its limited financial resources in those warfighting capabilities where it must lead potential adversaries—and be prepared to cede to the commercial or global marketplace those products where technological leadership is of little importance to the warfighter and commercial products may provide better value.

For technologies and industrial capabilities supporting *BA/BWA* warfighting leadership goals, it is important that the U.S. industrial base have a sufficient number of innovative suppliers to establish and sustain technological leadership and the necessary

[47] Foreign direct investment includes equity capital, inter-company debt, and reinvested earnings.
[48] Data from the Committee on Foreign Investment in the United States (CFIUS) also reflects this interest in U.S. Defense assets. The value of all corporate transactions reviewed by the Department involving the acquisition of U.S.-owned business assets by foreign interests is approaching $8 billion for 2004 following $10.7 billion and $9.3 billion in 2002 and 2003, respectively.

production capacity for potential military applications. Many Department activities are focused on making this a reality, and the DIBCS series complements these activities. It is a long forward pass to the future.

(This page intentionally left blank.)

SOURCES

Apgar, IV, Mahlon and John M. Keane. “New Business with the New Military.” *Harvard Business Review* September 2004: 45-56.

Bialos, Jeffrey P. and Stuart L. Koehl. *Getting to ‘Yes’ on Missile Defense: The Need to Rebalance U.S. Priorities & The Prospects of Transatlantic Cooperation.* Washington, DC: Center for Transatlantic Relations, Johns Hopkins University, 2004.

Booz Allen Hamilton. *Defense Industrial Base Capabilities Study (DIBCS) Sector Report: Protection.* Unpublished Manuscript. October 2004.

---. *Space Research and Development Industrial Base Study: Phase One Final Report*. McLean, Virginia: February 2002.

---. *Space Research and Development Industrial Base Study: Phase Two Final Report*. McLean, Virginia: August 2002.

---. *U.S. Defense Industry Under Siege – An Agenda for Change.* McLean, Virginia: 2000.

---. *Beyond MilSpec – The Case For Radical Transformation*. McLean, Virginia: 1995.

Cole, Tony, Critical Infrastructure Protection Programs, Symantec Corporation. Personal interview. October 14, 2004.

Coyer, Dane, Senior Vice-President & General Manager Field Operations, SRD. Personal interview. October 15, 2004.

Cumming, Colin, Chief Executive Officer, Nomadics, Inc. Personal interview. October 22, 2004.

Elkstrom, George, Vice-President, Finance, EluSys Therapautics, Inc. Personal interview. October 20, 2004.

Garamone, Jim. “A Short History of Homeland Defense.” *American Forces Press Service.* October 25, 2001.

Krepinevich, Andrew F. *Operation Iraqi Freedom: A First-Blush Assessment*. Washington, DC: Center for Strategic and Budgetary Assessments, 2003.

Lewis, Leslie, et. al., “Utilizing the OBRM Framework for the JWCA Integration Activity,” *Joint Warfighting Capabilities Integration*, National Defense Research Institute, 1998.

Pendall, David W. “Effects-Based Operations and the Exercise of National Power.” *Military Review*, January-February 2004.

Poston, Erick, Military-Government Business Unit Manager, Oakley, Inc. Personal interview. October 13, 2004.

Todaro, Maureen, Director, Communications, Viisage Technology, Inc. Personal interview. October 28, 2004.

Uniejewski, Joseph, Senior Vice-President, Corporate Development & Chief Technology Officer, RSA Security, Inc. Personal interview. October 28, 2004.

United States. Air Force. Secretary of the Air Force. “Air Force Doctrine Document 2-1- Air Warfare.“ January 2000.

---. Air Force. Secretary of the Air Force. “Air Force Doctrine Document 2-2- Air Warfare.“November 2001.

---. Air Force. Secretary of the Air Force. “Air Force Doctrine Document 2-3 – Military Operations Other Than War.” July 2000.

---. Air Force. Chief of Staff of the Air Force. *Air Force Task List*. August 1998.

---. Army. Chief of Staff of the Army. *Army Universal Task List (FM 7-15)*. August 2003.

---. Army. Chief of Staff of the Army. “Army Vision 2010.” 1996.

---. Chairman of the Joint Chiefs of Staff, Department of Defense. *Chairman of the Joint Chiefs of Staff Instruction: Joint Capabilities Integration and Development System (CJCSI 3170.01D)*. February 2004.

---. Chairman of the Joint Chiefs of Staff. Department of Defense. *Chairman of the Joint Chiefs of Staff Manual: Universal Joint Task List (CJCSI 3500.04C)*. July 1, 2002.

---. Chairman of the Joint Chiefs of Staff. Department of Defense. *Joint Vision 2010*. 1996.

---. Department of Defense, OUSD (AT&L) Office of Small and Disadvantaged Business Utilization. 2004. <http://www.acq.osd.mil/sadbu/statistics/goals.htm>.

---. Department of Defense. “Initiation of a Joint Capabilities Development Process.” Secretary of Defense Memorandum, October 31, 2003.

---. Department of Defense. “Operation of the Defense Acquisition System.” *Department of Defense Instruction 5000.2*. May 12, 2003.

---. Department of Defense. “The Defense Acquisition System.” *Department of Defense Directive 5000.1*. May 12, 2003.

---. Department of the Navy. “Forward…from the Sea.” 1994.

---. Department of the Navy. Headquarters United States Marine Corps. “Marine Corp Strategy 21.” 2000.

---. Department of the Navy. Headquarters United States Marine Corps. *Operational Maneuver from the Sea*. June 1996.

---. Department of the Navy. *Naval Mission Essential Task List.* June 2000.

---. Department of the Navy. United States Coast Guard. “Coast Guard 2020.” 1998.

---. Director, Defense Research and Engineering, Department of Defense. *Joint Warfighting Science and Technology Plan*. February 2002.

---. House of Representatives. *United States Code: Title 10 – Section 2504*. March 15, 1989.

---. Joint Staff, Department of Defense. *Joint Functional Concept – Battlespace Awareness.* December 31, 2003.

United States. Joint Staff, Department of Defense. *Joint Functional Concept – Command and Control.* February 2004.

---. Joint Staff, Department of Defense. *Joint Functional Concept – Focused Logistics*. December 2003.

---. Joint Staff, Department of Defense. *Joint Functional Concept – Force Application.* February 2004.

---. Joint Staff, Department of Defense. *Joint Functional Concept – Protection*. December 2003.

---. Joint Staff, Department of Defense. *Joint Functional Concept – Stability Operations*. September 2004.

---. Joint Staff, Department of Defense. *Joint Functional Concept – Strategic Deterrence*. February 2004.

---. Joint Staff, Department of Defense. *Joint Operating Concept – Homeland Security*. February 2004.

---. Office of the Under Secretary of Defense (Acquisition, Technology & Logistics). "Fiscal Year (FY) 2004 Major Defense Acquisition Program (MDAP) Lists." Acting Under Secretary of Defense (Acquisition, Technology & Logistics) Memorandum, June 4, 2004.

---. Office of the Under Secretary of Defense (Acquisition, Technology & Logistics). "Implementation Plan for the Management of the Chemical Biological Defense Program." Under Secretary of Defense (Acquisition, Technology & Logistics), Memorandum, April 22, 2003.

---. Office of the Deputy Under Secretary of Defense (Industrial Policy) *Defense Industrial Base Capabilities Study: Battlespace Awareness.* Washington: Office of the Deputy Under Secretary of Defense (Industrial Policy), January 2004.

---. Office of the Deputy Under Secretary of Defense (Industrial Policy) *Defense Industrial Base Capabilities Study: Command and Control.* Washington: Office of the Deputy Under Secretary of Defense (Industrial Policy), June 2004.

---. Office of the Deputy Under Secretary of Defense (Industrial Policy) *Defense Industrial Base Capabilities Study: Force Application.* Washington: Office of the Deputy Under Secretary of Defense (Industrial Policy), October 2004.

---. Office of the Deputy Under Secretary of Defense (Industrial Policy) *Transforming the Defense Industrial Base: A Roadmap*. Washington: Office of the Deputy Under Secretary of Defense (Industrial Policy), February 2003.

(This page intentionally left blank.)

ACRONYMS

ACTD	Advanced Concept Technology Demonstration
ADM	Acquisition Decision Memorandum
ADS	Active Denial System
AOC-WS	Air Operations Center – Weapon System
AS&C	Advanced Systems & Concepts
ASD(HD)	Assistant Secretary of Defense for Homeland Defense
AT&L	Acquisition, Technology & Logistics
ATIRCM/CMWS	Advanced Threat Infrared Countermeasure/Common Missile Warning System
BA	Battlespace Awareness
BA/BWA	Be Ahead and Be Way Ahead
BAH	Booz Allen Hamilton, Inc.
C2	Command and Control
C-5 RERP	C-5 Reliability Enhancement and Re-Engineering Program
C-17	Globemaster III Advanced Cargo Aircraft
C-130	Hercules Cargo Aircraft
C3I	Command, Control, Communications, and Intelligence
CAR	Capability Area Review
CBR	Chemical, Biological, and Radiological
CBRN	Chemical, Biological, Radiological, and Nuclear
CBRNE	Chemical, Biological, Radiological, Nuclear, and Explosive
CFIUS	Committee on Foreign Investment in the United States
CH-47	Cargo Helicopter Upgrade
Chem DeMil	Chemical Demilitarization Program
CSIS	Center for Strategic & International Studies
CJCSI	Chairman of the Joint Chief of Staff's Instruction
COCOM	Combatant Command
COTS	Commercial Off-the-Shelf
CTO	Chief Technology Officer
CVN 21	21st Century Aircraft Carrier
DAB	Defense Acquisition Board
DACP	Defense Acquisition Challenge Program
DARPA	Defense Advanced Research Projects Agency
DCGS	Distributed Common Ground System
DCMA	Defense Contract Management Agency
DDR&E	Director, Defense Research and Engineering
DHS	Department of Homeland Security
DIBCS	Defense Industrial Base Capabilities Study
DIBCS BA	*Defense Industrial Base Capabilities Study: Battlespace*

	Awareness
DIBCS C2	*Defense Industrial Base Capabilities Study: Command & Control*
DIBCS FA	*Defense Industrial Base Capabilities Study: Force Application*
DIBCS FL	*Defense Industrial Base Capabilities Study: Focused Logistics*
DoD	Department of Defense
DPAS	Defense Priorities and Allocation System
DSM	Dutch State Mines
DUSD(AS&C)	Deputy Under Secretary of Defense (Advanced Systems & Concepts)
DUSD (IP)	Deputy Under Secretary of Defense (Industrial Policy)
E-2C	Advanced Hawkeye Aircraft
EMP	Electromagnetic Pulse
FA	Force Application
F/A-22	Raptor Fighter/Attack Aircraft
FBCB2	Force XXI Battle Command Battalion/Brigade and Below
FCB	Functional Capability Board
FCS	Future Combat System
FCT	Foreign Comparative Test
FFRDC	Federally Funded Research & Development Center
FL	Focused Logistics
FMTV	Family of Medium Tactical Vehicles
FY	Fiscal Year
GCSS	Global Combat Support System
GMLRS	Guided Multiple Launch Rocket System
GNC	Guidance, Navigation, and Control
GPS	Global Positioning System
HSR	Hart-Scott-Rodino
HQ	Headquarters
IAB	Investment Advisory Board
IB	Industrial Base
IBIF	Industrial Base Investment Fund
ICBM	Intercontinental Ballistic Missile
IDA	Institute for Defense Analyses
IED	Improvised Explosive Devices
IP	Industrial Policy
IR&D	Independent Research & Development
IRBM	Intermediate Range Ballistic Missile
IT	Information Technology
JCIDS	Joint Capabilities and Integration Development System
JDAM	Joint Direct Attack Munition
JFC	Joint Functional Concept
JSF	Joint Strike Fighter
JTAMDO	Joint Surveillance Target Attack Radar System
KEI	Kinetic Energy Interceptor

LLC	Limited Liability Company
MH-60R	Multi-Mission Helicopter Upgrade
MH-60S	Knighthawk Multi-Mission Helicopter
MM III	Minuteman III
mm	Millimeter
MPF	Maritime Prepositioning Force
MPS	Mission Planning System
NAICS	North American Industry Classification System
NCO	Net Centric Operations
NDIA	National Defense Industrial Association
NII	Networks and Information Integration
NORA™	Non-Obvious Relationship Awareness™
NPOESS	National Polar-orbiting Operational Environmental Satellite System
NRE	Non-recurring Engineering
ODUSD (IP)	Office of the Deputy Under Secretary of Defense (Industrial Policy)
OEF/OIF	Operation Enduring Freedom/Operation Iraqi Freedom
OPNAV	Naval Operations Staff
OSD	Office of the Secretary of Defense
OUSD (AT&L)	Office of the Under Secretary of Defense (Acquisition, Technology & Logistics)
PAC-3	Patriot Advanced Capability-Phase 3
PAIR	Priority Allocation of Industrial Resources
PDUSD (AT&L)	Principal Deputy Under Secretary of Defense (Acquisition, Technology & Logistics)
PEO	Program Executive Officer
PJFC	Protection Joint Functional Concept
PM	Program Manager
PMFCC	Program Manager Functional Capability Conference
QRSP	Quick Reaction Special Projects Program
RAMICS	Rapid Airborne Mine Clearance System
R&D	Research and Development
RFID	Radio Frequency Identification
RFP	Requests For Proposal
RPF	Rigid Polyurethane Foam
RPG	Rocket Propelled Grenade
RF	Radio Frequency
S&T	Science and Technology
SAG	Senior Advisory Group
SAM	Surface-to-air-Missile
SAPI	Small Arms Protective Insert
SBIR	Small Business Innovation Research program
SBIRS-High	Space-Based Infrared System - High
SC-SSP	Supercavitating-Supersonic Projectile

SME	Subject Matter Expert
SOCOM	Special Operations Command
SoS	Security of Supply
SRD	Systems Research & Development
SSA	Special Security Agreement
T-AKE	Lewis and Clark Class of Auxiliary Dry Cargo Ships
TRL	Technology Readiness Level
TTI	Technology Transfer Initiative
U.K.	United Kingdom
U.S.	United States
USAF	United States Air Force
USD (AT&L)	Under Secretary of Defense (Acquisition, Technology, and Logistics)
USS	United States Ship
USSOCOM	United States Special Operations Command
USSPACECOM	United States Space Command
UUV	Unmanned Underwater Vehicle

APPENDIX A

DIBCS PROTECTION CAPABILITY FRAMEWORK

(This page intentionally left blank.)

Active Defense-in-Depth

Air Neutral
• None

Air Equal
• None

Air Be Ahead
• Destroy ICBM/IRBM with HE in endoatmospheric boost phase with land-launched ABM
• Destroy ICBM/IRBM with HE in endoatmospheric boost phase with sea-launched ABM
• Destroy multiple ICBM/IRBM in endoatmospheric boost phase by rapidly launching multiple ABMs from sea
• Defeat ICBM/IRBM countermeasures in boost phase- highly reflective materials
• Defeat ICBM/IRBM countermeasures in mid-course phase- balloon decoys
• Defeat ICBM/IRBM countermeasures in mid-course phase- radar absorbing materials
• Defeat ICBM/IRBM countermeasures in mid-course phase- highly reflective materials
• Defeat ICBM/IRBM countermeasures in mid-course phase- spin stabilization
• Defeat ICBM/IRBM countermeasures in mid-course phase- chaff
• Defeat ICBM/IRBM countermeasures in mid-course phase- jammers
• Destroy ICBM/IRBM reentry vehicles with HE in endoatmospheric terminal descent phase with land-launched ABM
• Destroy ICBM/IRBM reentry vehicles with HE in endoatmospheric terminal descent phase with sea-launched ABM
• Destroy ICBM/IRBM reentry vehicles with DE in endoatmospheric terminal descent phase with land-based laser
• Destroy TBM with HE in boost phase with land-launched ABM
• Destroy TBM with HE in boost phase with sea-launched ABM
• Destroy TBM reentry vehicles with HE in endoatmospheric mid-course phase with land-launched ABM
• Destroy TBM reentry vehicles with HE in endoatmospheric mid-course phase with sea-launched ABM

Active Defense-in-Depth – Cont.

Air **Be Ahead – Cont.**
• Destroy TBM reentry vehicles (low RCS warheads) with HE in endoatmospheric terminal descent phase with land-launched ABM
• Destroy TBM reentry vehicles (low RCS warheads) with HE in endoatmospheric terminal descent phase with sea-launched ABM
• Destroy TBM reentry vehicles (low RCS warheads) with DE in endoatmospheric terminal descent phase with land-based laser
• Destroy cruise missiles with projectiles at close range
• Destroy cruise missiles with HE at close range (with missiles)
• Destroy cruise missiles with DE at close range
• Deceive active radar missile with dispensable countermeasure in terminal phase
• Deceive IR missile with dispensable countermeasure in terminal phase
• Deceive IR missile with non-dispensable countermeasure in terminal phase
• Deny/Disrupt missiles with EW jamming in terminal phase
• Deceive missiles with EW deception in terminal phase
• Deceive air-to-air missile fire control radar with towed decoys at long range
• Deceive air-to-air missile fire control radar with launched decoys at long range
• Deny/Disrupt aircraft fire control radar with EW jamming at medium range
• Deceive aircraft fire control radar with towed decoys at medium range
• Deceive aircraft fire control radar with launched decoys at medium range
• Deny/Disrupt active radar air-to-air missile with EW jamming at medium range
• Deceive active radar air-to-air missile with EW deception at medium range
• Deny/Disrupt laser beam riding or laser homing air-to-air missile with laser countermeasures in terminal phase
• Deceive IR air-to-air missile with dispensable IR countermeasures in terminal phase
• Deceive IR air-to-air missile with non-dispensable IR countermeasures in terminal phase
• Deceive active radar air-to-air missile with dispensable countermeasures in terminal phase
• Deny/Disrupt active radar air-to-air missile with EW jamming in terminal phase
• Deceive active radar air-to-air missile with EW deception in terminal phase
• Deceive air-to-air missile with towed decoy in terminal phase
• Deceive air-to-air missile with launched decoy in terminal phase
• Destroy tactical short-range surface/air-to-surface missile in boost phase with DE

Active Defense-in-Depth – Cont.

Air Be Ahead – Cont.
• Destroy tactical short-range surface/air
• Destroy tactical short-range surface/air-to-surface missile in mid-course phase with DE
• Destroy tactical short-range surface/air-to-surface missile in mid-course phase with HE with an ABM
• Destroy tactical short-range surface/air-to-surface missile in terminal phase with DE
• Destroy tactical short-range surface/air-to-surface missile in terminal phase with HE with an ABM
• Destroy tactical short-range surface/air-to-surface missile in terminal phase with projectiles

Air Be Way Ahead
• Destroy tactical short-range surface/air-to-surface missile in boost phase with KEI with an ABM
• Destroy tactical short-range surface-to-surface missile in mid-course phase with KEI with an ABM
• Deceive air-to-air missile fire control radar with EW deception at long range
• Deceive aircraft fire control radar with EW deception at medium range
• Destroy air-to-air missile with DE (airborne laser) at medium range
• Destroy air-to-air missile with an air-to-air missile at medium range
• Destroy air-to-air missile with DE in terminal phase
• Destroy cruise missiles with DE at medium range
• Destroy cruise missiles with HE with surface-to-air missile at medium range
• Destroy ICBM/IRBM with DE in endoatmospheric boost phase with sea-based laser
• Destroy ICBM/IRBM with DE in endoatmospheric boost phase with space-based laser
• Destroy ICBM/IRBM with KEI in endoatmospheric boost phase with land-launched ABM
• Destroy ICBM/IRBM with KEI in endoatmospheric boost phase with sea-launched ABM
• Destroy ICBM/IRBM with KEI in endoatmospheric boost phase with space-based ABM

Active Defense-in-Depth – Cont.

Air Be Way Ahead – Cont.
• Destroy multiple ICBM/IRBM in endoatmospheric boost phase by rapidly launching multiple ABMs from land
• Destroy ICBM/IRBM reentry vehicles with KEI in endoatmospheric terminal descent phase with land-launched ABM
• Destroy ICBM/IRBM reentry vehicles with KEI in endoatmospheric terminal descent phase with sea-launched ABM
• Destroy ICBM/IRBM reentry vehicles with DE in endoatmospheric terminal descent phase with sea-based laser
• Destroy ICBM/IRBM reentry vehicles with DE in endoatmospheric terminal descent phase with air-based laser
• Destroy TBM with DE in boost phase with air-based laser
• Destroy TBM with DE in boost phase with sea-based laser
• Destroy TBM with DE in boost phase with space-based laser
• Destroy TBM with KEI in boost phase with land-launched ABM
• Destroy TBM with KEI in boost phase with sea-launched ABM
• Destroy TBM in boost phase with space-based KEI
• Destroy TBM reentry vehicles with KEI in endoatmospheric mid-course phase with land-launched ABM
• Destroy TBM reentry vehicles with KEI in endoatmospheric mid-course phase with sea-launched ABM
• Destroy TBM reentry vehicles with DE in endoatmospheric mid-course phase with land-based laser
• Destroy TBM reentry vehicles with DE in endoatmospheric mid-course phase with sea-based laser
• Destroy TBM reentry vehicles with DE in endoatmospheric mid-course phase with air-based laser
• Destroy TBM reentry vehicles with DE in endoatmospheric mid-course phase with space-based laser
• Destroy TBM reentry vehicles (low RCS warheads) with KEI in endoatmospheric terminal descent phase with land-launched ABM
• Destroy TBM reentry vehicles (low RCS warheads) with KEI in endoatmospheric terminal descent phase with sea-launched ABM
• Destroy TBM reentry vehicles (low RCS warheads) with DE in endoatmospheric terminal descent phase with sea-based laser
• Destroy TBM reentry vehicles (low RCS warheads) with DE in endoatmospheric terminal descent phase with air-based laser

Active Defense-in-Depth – Cont.

Sea Neutral
• None

Sea Equal
• Destroy torpedo with a torpedo net at close range
• Destroy magnetic mines with aircraft towed countermeasures at long range
• Destroy pressure mines with aircraft towed countermeasures at long range
• Destroy/disable moored mines by cutting tethers and releasing mines to surface for destruction at medium range
• Destroy magnetic mines with towed magnetic sweeps at medium range
• Destroy pressure mines with towed pressure sweeps at medium range
• Destroy floating (surface and near surface) mine with HE at close range
• Destroy floating (surface and near surface) mine with projectiles at close range

Sea Be Ahead
• Deceive torpedo with expendable acoustic countermeasures at long range
• Deceive torpedo with expendable magnetic countermeasures at long range
• Destroy torpedo with a torpedo at medium range
• Deceive torpedo with expendable acoustic countermeasures at medium range
• Deceive torpedo with expendable magnetic countermeasures at medium range
• Destroy torpedo with a torpedo at close range
• Deceive torpedo with expendable acoustic countermeasures at close range
• Deceive torpedo with towed acoustic countermeasures at close range
• Deceive torpedo with expendable magnetic countermeasures at close range
• Deceive torpedo with towed magnetic countermeasures at close range
• Deceive torpedo with magnetic countermeasures at close range
• Destroy moored mines with air delivered countermeasures at long range
• Destroy bottom mines with air delivered countermeasures at long range
• Destroy drifting mines with air delivered countermeasures at long range
• Destroy shallow water mines with air delivered countermeasures at long range
• Destroy acoustic mines with aircraft towed countermeasures at long range
• Destroy shallow water mines with aircraft towed countermeasures at long range

Active Defense-in-Depth – Cont.

Sea Be Ahead – Cont.
• Destroy acoustic mines with ship/sub-based mine countermeasures at long range
• Destroy magnetic mines with ship/sub-based mine countermeasures at long range
• Destroy pressure mines with ship/sub-based mine countermeasures at long range
• Destroy combination mines with ship/sub-based mine countermeasures at long range
• Destroy acoustic mines with towed acoustic sweeps at medium range
• Destroy combination mines with towed combination sweeps at medium range
• Destroy acoustic mines with ship/sub based mine countermeasures at medium range
• Destroy magnetic mines with ship/sub based mine countermeasures at medium range
• Destroy pressure mines with ship/sub based mine countermeasures at medium range
• Destroy combination mines with ship/sub based mine countermeasures at medium range
• Destroy floating (surface and near surface) mine with DE at close range
• Deceive magnetic mine with magnetic expendable counter measure at close range
• Deceive acoustic mine with acoustic expendable counter measure at close range
• Deceive acoustic signature mine with acoustic expendable counter measure at close range

Active Defense-in-Depth – Cont.

Sea **Be Way Ahead**
• Destroy torpedo with a torpedo at long range
• Destroy supercavitational torpedo with a supercavitational torpedo at long range
• Destroy torpedo with supercavitational projectiles at long range
• Destroy supercavitational torpedo with supercavitational projectiles at long range
• Destroy supercavitational torpedo with a supercavitational torpedo at medium range
• Destroy torpedo with supercavitational projectiles at medium range
• Destroy supercavitational torpedo with supercavitational projectiles at medium range
• Destroy mines with a supercavitational projectile at long range
• Locate, classify and destroy bottom mines with ship-based off-board mine countermeasures at long range
• Locate, classify and destroy bottom mines with submarine-based off-board mine countermeasures at long range
• Destroy mines with a supercavitational projectile at medium range

Active Defense-in-Depth – Cont.

Land Neutral
• None

Land Equal
• Destroy double impulse and blast proof mines to create breach lanes with HE at long range
• Destroy double impulse and blast proof mines to create breach lanes and landing zone with overpressure weapon at long range
• Destroy double impulse and blast proof mines with air fired (rotary fixed wing) high velocity projectiles at long range
• Destroy double impulse and blast proof mines to create breach lanes with HE at medium range
• Destroy double impulse and blast proof mines with shock waves at medium range
• Destroy double impulse and blast proof mines with vehicle mounted devices at close range
• Destroy double impulse and blast proof mines with water jets at close range
• Defeat explosion with high strength covers at close range
• Detonate mines in pressure vessels that contain all shock wave and fragmentations at close range
• Destroy chemical/biological mines with high temperature incendiaries at close range
• Deny/Disrupt RPG target engagement with obscurants at medium range
• Destroy IED through pre-detonation with high velocity projectiles at long range
• Destroy IED through pre-detonation with localized over pressure weapon at long range
• Disrupt electronic triggering of IEDs with EW jamming at long range
• Destroy IEDs through premature detonation with explosive nets at medium range
• Prematurely detonate IED with EW jamming at medium range
• Deny/disrupt IED command detonation signals with EW jamming at medium range

Active Defense-in-Depth – Cont.

Land Be Ahead
• Destroy double impulse and blast proof mines to create breach lanes with DE-microwave and laser at medium range
• Destroy double impulse and blast proof mines with robotic assisted detonators at medium range
• Destroy (neutralize) mines with chemical oxidizers and solvents at close range
• Destroy double impulse and blast proof mines with down-looking active laser at close range
• Prevent detonation with rigid foams at close range
• Detonate and neutralize chemical/biological mines in pressure vessels that contain all shock waves and neutralize chem/bio agents at close range
• Destroy MRLS projectiles with radar-directed projectiles in mid-course
• Destroy MRLS projectiles with DE in mid-course
• Destroy MRLS projectiles with radar-directed projectiles in terminal phase
• Destroy MRLS projectiles with DE in terminal phase
• Destroy artillery shells through pre-detonation of radio proximity fuses with forward projecting radio field at long range
• Destroy artillery shells through pre-detonation of radio proximity fuses with forward projecting radio field at medium range
• Destroy artillery shells with DE at close-range
• Destroy artillery shells with radar-guided projectiles at close range
• Destroy artillery shells through pre-detonation of radio proximity fuses with forward projecting radio field at close range
• Deny/Disrupt RPG attack by deflecting RPG with HE at long range
• Destroy RPG with fragmentation rounds (combined HE and fragmenting projectiles) at long range
• Destroy RPG with high velocity projectiles at long range
• Deny/Disrupt RPG attack by blinding shooter with lasers
• Destroy RPG with self fusing fragmentation rounds at close range
• Destroy (predetonate) RPG with forward firing catcher nets at close range
• Destroy IED through premature detonation with DE at long range
• Destroy IED through pre-detonation with IR triggering of IEDs
• Destroy IED through premature detonation with EW triggering of IEDs
• Disrupt IR triggering of IEDs with IR jamming at long range
• Prematurely detonate IED with IR jamming at medium range
• Prevent detonation with rigid foams at close range

Active Defense-in-Depth – Cont.

Land **Be Ahead – Cont.**
• Defeat detonation with high strength covers at close range
• Destroy (neutralize) IEDs with chemical oxidizers and solvents at close range

Land **Be Way Ahead**
• Destroy artillery shells with DE at long-range
• Destroy artillery shells with DE at medium-range

Active Defense-in-Depth – Cont.

Space Neutral
• None

Space Equal
• Destroy debris with DE from land-based laser
• Destroy debris with DE from airborne laser
• Destroy debris with DE from sea-based laser
• Destroy debris with DE from space-based laser

Space Be Ahead
• Defeat ASAT with DE in exoatmospheric boost phase with land-based laser
• Disrupt/Degrade ASAT C2 link in boost phase with land-based EW
• Disrupt/Degrade ASAT C2 link in boost phase with air-based EW
• Disrupt/Degrade ASAT C2 link in boost phase with sea-based EW
• Destroy multiple ASATs in exoatmospheric boost phase by rapidly launching multiple interceptors from sea
• Defeat ASAT with DE in exoatmospheric mid-course phase with land-based laser
• Disrupt/Degrade ASAT C2 link in mid-course phase with land-based EW
• Disrupt/Degrade ASAT C2 link in mid-course phase with air-based EW
• Disrupt/Degrade ASAT C2 link in mid-course phase with sea-based EW
• Destroy multiple ASATs in exoatmospheric mid-course phase by rapidly launching multiple interceptors from sea
• Defeat ASAT with DE in terminal phase with land-based laser
• Defeat ICBM/IRBM with DE in exoatmospheric mid-course phase with land-based laser
• Destroy multiple ICBM/IRBMs in exoatmospheric mid-course phase by rapidly launching multiple interceptors from sea
• Defeat DE in firing sequence phase with shutters
• Defeat RF in firing sequence with nulling

Active Defense-in-Depth – Cont.

Space Be Way Ahead
• Defeat ASAT with DE in exoatmospheric boost phase with airborne laser
• Defeat ASAT with DE in exoatmospheric boost phase with sea-based laser
• Defeat ASAT with DE in exoatmospheric boost phase with space-based laser
• Destroy ASAT with KEI in exoatmospheric boost phase with land-launched interceptor
• Destroy ASAT with KEI in exoatmospheric boost phase with sea-launched interceptor
• Destroy ASAT with KEI in exoatmospheric boost phase with space-launched interceptor
• Disrupt/Degrade ASAT C2 link in boost phase with space-based EW
• Destroy multiple ASATs in exoatmospheric boost phase by rapidly launching multiple interceptors from land
• Destroy multiple ASATs in exoatmospheric boost phase by rapidly launching multiple interceptors from space
• Defeat ASAT in exoatmospheric boost phase with space-launched countermeasures
• Defeat ASAT with DE in exoatmospheric mid-course phase with airborne laser
• Defeat ASAT with DE in exoatmospheric mid-course phase with sea-based laser
• Defeat ASAT with DE in exoatmospheric mid-course phase with space-based laser
• Destroy ASAT with KEI in exoatmospheric mid-course phase with land launched interceptor
• Destroy ASAT with KEI in exoatmospheric mid-course phase with sea launched interceptor
• Destroy ASAT with KEI in exoatmospheric mid-course phase with space launched interceptor
• Disrupt/Degrade ASAT C2 link in mid-course phase with space-based EW
• Destroy multiple ASATs in exoatmospheric mid-course phase by rapidly launching multiple interceptors from land
• Destroy multiple ASATs in exoatmospheric mid-course phase by rapidly launching multiple interceptors from space
• Defeat ASAT in exoatmospheric mid-course phase with space-launched countermeasures
• Defeat ASAT with DE in terminal phase with airborne laser
• Defeat ASAT with DE in terminal phase with sea-based laser
• Defeat ASAT with DE in terminal phase with space-based laser

Active Defense-in-Depth – Cont.

Space Be Way Ahead – Cont.
• Destroy ASAT with KEI in terminal phase with space-launched interceptor
• Defeat ASAT in terminal phase with space-launched countermeasures
• Defeat ICBM/IRBM with DE in exoatmospheric mid-course phase with airborne laser
• Defeat ICBM/IRBM with DE in exoatmospheric mid-course phase with sea-based laser
• Defeat ICBM/IRBM with DE in exoatmospheric mid-course phase with space-based laser
• Destroy ICBM/IRBM with KEI in exoatmospheric mid-course phase with land-launched interceptor
• Destroy ICBM/IRBM with KEI in exoatmospheric mid-course phase with sea-launched interceptor
• Destroy ICBM/IRBM with KEI in exoatmospheric mid-course phase with space-launched interceptor
• Destroy multiple ICBM/IRBMs in exoatmospheric mid-course phase by rapidly launching multiple interceptors from land
• Destroy multiple ICBM/IRBMs in exoatmospheric mid-course phase by rapidly launching multiple interceptors from space
• Defeat DE in firing sequence phase with space launched countermeasures
• Defeat RF in firing sequence phase with space-launched countermeasures

Active Defense-in-Depth – Cont.

Cyber Neutral
• None

Cyber Equal
• None

Cyber Be Ahead
• Neutralize (disable) attacker that has penetrated network boundary
• Neutralize (disable) attacker that has penetrated enclave boundary
• Neutralize (disable) attacker that has penetrated computer boundary
• Neutralize (disable) automated scanning tools
• Terminate (remove) network or computer sniffers at network or enclave boundary
• Terminate (destroy) malicious programs (virus, worms) at network or enclave boundary
• Terminate (destroy) installation of back-doors or trap-doors
• Terminate unauthorized "half open" or fake network connections (attack against network connection kernels) that block or prevent authorized connections
• Terminate unauthorized network connections that "flood" network communication resources
• Terminate (remove) unauthorized packets within the network
• Terminate (remove) internal unauthorized programs that generate excessive number of internal (coding) messages, errors, or audit events
• Terminate (destroy) assisted logic attack or malicious code (virus) within network component (e.g., attack conducted from router)
• Terminate (destroy) assisted logic attack or malicious code (virus) between multiple components (e.g., attack conducted from router)
• Terminate (destroy) self-propagating and self-initiated attack (worms) within network component (e.g., attack conducted from router)
• Terminate (destroy) self-propagating and self-initiated attack within enclave boundary (e.g., within a server or computer supporting a portion of a network)
• Terminate (destroy) self-propagating and self-initiated attack within computing boundary (e.g., within a computer's local resource)

Active Defense-in-Depth – Cont.

Cyber **Be Way Ahead**
• Terminate simultaneous, coordinated and distributed attack against network, enclave and computing boundary connection points
• Terminate (remove) unauthorized programs that alter configuration information or configuration settings resulting in DoS
• Terminate (destroy) self-propagating and self-initiated attack within network and between multiple components (peer to peer attack that disrupt routing information and breaks the "trust" between components)

Asset Level Protection - Passive

Person(s) Neutral
• Protect an individual(s) from shock/stun
• Protect an individual(s) from electrical water streams
• Protect an individual(s) from a high voltage net
• Protect an individual(s) from exposed electrical hazards
• Protect an individual(s) from very loud, shrill noises
• Protect an individual(s) from voice synthesis/morphing

Person(s) Equal
• Protect an individual's head from projectiles and physical blows while allowing the individual to maintain sensory awareness (see, hear, smell)
• Protect an individual's hands from projectiles and physical blows while maintaining the individual's manual dexterity
• Protect an individual's feet from projectiles and physical blows while maintaining the individual's agility
• Protect an individual's hands from ballistic fragments while maintaining the individual's manual dexterity
• Protect an individual's legs from ballistic fragments while maintaining the individual's mobility
• Protect an individual's feet from ballistic fragments while preserving an individual's agility
• Protect an individual's head from heat/fire while allowing the individual to maintain sensory awareness (see, hear, smell)
• Protect an individual's arms from heat/fire while allowing continued full range-of-motion
• Protect an individual's hands from heat/fire while maintaining the individual's manual dexterity
• Protect an individual's legs from heat/fire while maintaining the individual's mobility
• Protect an individual's feet from heat/fire while preserving an individual's agility
• Protect an individual's arms from overpressure while maintaining the individual's full range-of-motion
• Protect an individual's hands from overpressure while maintaining the individual's manual dexterity

Asset Level Protection – Passive – Cont.

Person(s) Equal – Cont.
• Protect an individual's feet from overpressure while preserving the individual's agility
• Protect an individual from CBR contamination with impermeable, protective clothing that doesn't hamper an individual's ability to identify teammates
• Protect an individual from CBR contamination with impermeable, protective clothing that allows individual health monitoring
• Protect an individual from CBR contamination with impermeable, protective clothing that doesn't hamper an individual's ability to perform normal bodily functions
• Provide temporary, safe working environments for groups at-risk of terrorist-induced CBR attack
• Protect an individual(s) from maser energy
• Protect an individual(s) from thermal energy
• Protect an individual(s) from acoustic pulses
• Protect an individual(s) from sonic bullets (acoustic bullets)
• Protect an individual(s) from ultrasound
• Protect an individual(s) from infrasound
• Protect an individual from detection by an infrared sensor
• Protect an individual from detection by an underground, pressure sensor
• Protect an individual from detection by motion-detectors
• Protect an individual from detection by vibration sensors
• Prevent an individual from contracting heat-related injury or death
• Prevent an individual from contracting cold-related injury or death
• Protect an individual from high-G maneuvers
• Protect an individual from rapid acceleration
• Protect an individual from rapid change in pressurization without hampering the individual's cognitive and functional capacity
• Identify and counter subliminal visual and audio messages
• Identify and defeat holographic projections

Asset Level Protection – Passive – Cont.

Person(s) **Be Ahead**
• Protect an individual's body from projectiles and physical blows without hampering an individual's operational stamina in extreme temperatures
• Protect an individual's arms from projectiles and physical blows while allowing continued full range-of-motion
• Protect an individual's legs from projectiles and physical blows while maintaining the individual's mobility
• Protect an individual's head from fragments while allowing the individual to maintain sensory awareness (see, hear, smell)
• Protect an individual's body from fragments without hampering an individual's operational stamina in extreme temperature
• Protect an individual's arms from fragments while allowing continued full range-of-motion
• Protect an individual's body from heat/fire without hampering an individual's operational stamina in extreme temperature
• Protect an individual's head from overpressure while allowing the individual to maintain sensory awareness (see, hear, smell)
• Protect an individual's body from overpressure without hampering an individual's operational stamina in extreme temperature
• Protect an individual's legs from overpressure while maintaining the individual's mobility and agility
• Protect an individual from bacterial infection with appropriate chemoprophylaxis (chemoprophylaxis is administrating a drug such as a broad-spectrum of antibiotics) to prevent infectious disease)
• Protect an individual from bacterial infection with appropriate immunoprophylaxis (immunoprophylaxis is the administration of vaccines to provide persistent resilience to an agent)
• Protect an individual from viral infection with appropriate chemoprophylaxis (chemoprophylaxis is administering a drug (such as a broad-spectrum of antibiotics) to an individual(s) to prevent infectious disease)
• Protect an individual from viral infection with appropriate immunoprophylaxis (immunoprophylaxis is the administration of vaccines to provide persistent resilience to an agent)
• Protect an individual from rickettsial infection with appropriate chemoprophylaxis (chemoprophylaxis is administering a drug (such as a broad-spectrum of antibiotics) to an individual(s) to prevent infectious disease)
• Protect an individual from rickettsial infection with appropriate immunoprophylaxis (immunoprophylaxis is the administration of vaccines to provide persistent resilience to an agent)

Asset Level Protection – Passive – Cont.

Person(s) **Be Ahead – Cont.**
• Protect an individual from a toxin with appropriate chemoprophylaxis (chemoprophylaxis is administering a drug (such as a broad-spectrum of antibiotics) to an individual(s) to prevent infectious disease)
• Protect an individual from chlamydial infection with appropriate chemoprophylaxis (chemoprophylaxis is administering a drug (such as a broad-spectrum of antibiotics) to an individual(s) to prevent infectious disease)
• Protect an individual from chlamydial infection with appropriate immunoprophylaxis (immunoprophylaxis is the administration of vaccines to provide persistent resilience to an agent)
• Protect an individual from fungal infection with appropriate chemoprophylaxis (chemoprophylaxis is administering a drug (such as a broad-spectrum of antibiotics) to an individual(s) to prevent infectious disease)
• Protect an individual from fungal infection with appropriate immunoprophylaxis (immunoprophylaxis is the administration of vaccines to provide persistent resilience to an agent)
• Protect an individual from lethal and non-lethal chemical agents entering the body through the nose, mouth, or eyes
• Protect an individual from a lethal and non-lethal chemical agents entering the body through contact with skin, absorption through the skin, and entry through cuts or abrasions of the skin
• Protect an individual from CBR contamination with impermeable, protective clothing that doesn't hamper an individual's ability to communicate orally
• Protect an individual from CBR contamination with impermeable, protective clothing that doesn't hamper an individual's sensory awareness (see, hear, smell)
• Protect an individual from CBR contamination with impermeable, protective clothing that doesn't hamper an individual's manual dexterity
• Protect an individual from CBR contamination with impermeable, protective clothing that allows an individual to work extended hours in an extreme temperature environment
• Protect an individual from CBR contamination with impermeable, protective clothing that self-seals if punctured or torn
• Protect an individual from CBR contamination with impermeable, protective clothing that is simple and quick to don and remove
• Provide a rapid, temporary shelter from CBR contamination to without compromising the group's battlespace awareness
• Provide a rapid, temporary shelter from CBR contamination to without hampering the group's responsiveness

Asset Level Protection – Passive – Cont.

Person(s) **Be Ahead – Cont.**
• Move a group through a contaminated environment unscathed
• Protect an individual(s) from direct ocular damage by a low power visible laser
• Protect an individual(s) from diffuse ocular damage by a medium power laser (UV, visible, near-IR and IR)
• Protect an individual(s) from direct ocular damage by a medium power laser (UV, visible, near-IR and IR)
• Protect an individual's neural network from high power microwave
• Protect an individual from visual detection in dynamic settings (forest, desert, water, etc.) and lighting
• Protect an individual from detection by an electro-optical sensor
• Protect an individual from detection by an acoustic sensor
• Protect an individual from detection of personal C4 devices
• Protect an individual from detection by radar

Person(s) **Be Way Ahead**
• Protect an individual from a toxin with appropriate immunoprophylaxis (immunoprophylaxis is the administration of vaccines to provide persistent resilience to an agent)
• Protect an individual(s) from direct ocular damage by a high power laser (UV, visible, near-IR and IR)
• Protect an individual(s) from diffuse ocular damage by a high power laser (UV, visible, near-IR and IR)
• Protect an individual(s) from fire hazard and skin damage by a high power laser (UV, visible, near-IR and IR)

Asset Level Protection – Passive – Cont.

Point – Platforms **Neutral**
• None

Point – Platforms **Equal**
• Protect an air vehicle from HE (blast, heat and fragmentation effects)
• Protect an air vehicle from nuclear blast (shockwave, EMP, heat and radiation effects)
• Protect an air vehicle from projectiles (kinetic, explosive and shaped)
• Protect a surface vessel from HE (blast, heat and fragmentation effects)
• Protect a surface vessel from nuclear blast (shockwave, EMP, heat and radiation effects)
• Protect a surface vessel from projectiles (kinetic, explosive and shaped)
• Protect a subsurface vessel from HE (blast, heat and fragmentation effects)
• Protect a subsurface vessel from nuclear blast (shockwave, EMP, heat and radiation effects)
• Protect a subsurface vessel from projectiles (kinetic, explosive and shaped)
• Protect a vehicle from HE (blast, heat and fragmentation effects)
• Protect a vehicle from nuclear blast (shockwave, EMP, heat and radiation effects)
• Protect satellites from HE (blast, heat, and fragmentation effects)
• Protect satellites from extreme temperatures
• Protect satellites from radiation
• Protect satellites from electrostatic discharge
• Protect ICBM from radar detection
• Protect ICBM from IR detection
• Protect ICBMs in exoatmospheric phase from projectiles
• Protect launch/re-entry vehicles from HE (blast, heat, and fragmentation effects)
• Protect launch/re-entry vehicles from projectiles
• Protect launch/re-entry vehicles from extreme temperatures
• Protect launch/re-entry vehicles from radiation
• Protect launch/re-entry vehicles from electrostatic discharge
• Protect launch/re-entry vehicles sensors from sensory overload
• Protect launch/re-entry vehicles during launch from extreme vibration and external forces
• Protect computers and servers from compromising emanations

Asset Level Protection – Passive – Cont.

Point – Platforms **Equal – Cont.**
• Protect computers and servers from electrical overload
• Protect computers and servers from magnetic attack
• Protect computers and servers from physical shock
• Protect computers from environmental effects of temperature and moisture
• Protect computers from environmental effects of particulate matter (dust, smoke, et al)
• Protect wirelines (cables) from electrical overload
• Protect wireline (cables) from magnetic attack
• Protect wireline (cables) from compromising emanations
• Protect wireline (cables) from environmental effects of temperature and moisture

Point – Platforms **Be Ahead**
• Protect an air vehicle C4I systems from EW jamming
• Protect an air vehicle C4I systems from non-nuclear EMP
• Protect an air vehicle from EO/visual detection
• Protect an air vehicle from acoustic detection
• Protect manned air vehicle from NBC attack with special filters
• Protect an IR sensor from IR countermeasures
• Protect a laser sensor from laser countermeasures
• Protect a active radar sensor from active radar countermeasures
• Protect a surface vessel C4I systems from EW jamming
• Protect a surface vessel C4I systems from non-nuclear EMP
• Protect a surface vessel from EO/visual detection
• Protect a surface vessel from IR detection
• Protect a surface vessel from laser detection
• Protect a surface vessel from acoustic detection
• Protect a surface vessel from multi-spectral detection
• Protect a surface vessel from magnetic detection
• Protect a surface vessel from CBRNE contamination
• Protect a subsurface vessel C4I systems from EW jamming
• Protect a subsurface vessel C4I systems from non-nuclear EMP
• Protect a subsurface vessel from EO/visual detection
• Protect a subsurface vessel from radar detection (pulsed, CW and synthetic)

Asset Level Protection – Passive – Cont.

Point – Platforms **Be Ahead – Cont.**
• Protect a vehicle from projectiles (kinetic, explosive, shaped, and combination)
• Protect a vehicle C4I systems from EW jamming
• Protect a vehicle C4I systems from non-nuclear EMP
• Protect a vehicle from EO/visual detection
• Protect a vehicle from radar detection (pulsed, CW and synthetic)
• Protect a vehicle from IR detection
• Protect a vehicle from laser detection
• Protect a vehicle from seismic detection
• Protect a vehicle from acoustic detection
• Protect a vehicle from multi-spectral detection
• Protect a vehicle vessel from magnetic detection
• Protect a vehicle crew from NBC attack with special air filters
• Protect satellites from DE
• Protect satellites from projectiles (asteroids, space debris, other satellites)
• Protect space-based sensors from sensory overload
• Protect a satellite from EO detection
• Protect a satellite from IR detection
• Protect a satellite from laser detection
• Protect satellite during launch from extreme vibration and external forces
• Protect ICBMs in exoatmospheric phase from nuclear blast
• Protect ICBMs in exoatmospheric phase from DE
• Protect ICBM from EO detection
• Protect ICBM from Laser detection
• Protect launch/re-entry/ICBM vehicles from DE
• Protect launch/re-entry vehicles from EW
• Protect computers and server from EMP

Asset Level Protection – Passive – Cont.

Point – Platforms **Be Way Ahead**
• Protect an air vehicle from DE
• Protect air crew from DE
• Protect an air vehicle from radar detection (pulsed, CW and synthetic)
• Protect an air vehicle from IR detection
• Protect an air vehicle from laser detection
• Protect an air vehicle from multi-spectral detection
• Protect a surface vessel from DE
• Protect a surface vessel from radar detection (pulsed, CW and synthetic)
• Protect a subsurface vessel from IR detection
• Protect a subsurface vessel from laser detection
• Protect a subsurface vessel from acoustic detection
• Protect a subsurface vessel from multi-spectral detection
• Protect a subsurface vessel from magnetic detection
• Protect satellites from EW
• Protect a satellite from radar detection

Asset Level Protection – Passive – Cont.

Point - Structures Neutral
• None

Point - Structures Equal
• Protect a building from conventional HE (blast, heat and fragmentation effects)
• Protect a building from projectiles (kinetic, explosive, shaped, and combination)
• Protect a building from intrusion (unauthorized entry)
• Protect a building from forced entry tools
• Protect a building from electronic overload
• Protect a building from unconventionally delivered weapons
• Protect a hangar/storage facility from conventional HE (blast, heat and fragmentation effects)
• Protect a hangar/storage facility from projectiles (kinetic, explosive, shaped, and combination)
• Protect a C3/leadership node from conventional HE (blast, heat and fragmentation effects)
• Protect a C3/leadership node from projectiles (kinetic, explosive, shaped, and combination)
• Protect a C3/leadership node from intrusion (unauthorized entry)
• Protect underground bunker entry/exit points and air shafts from conventional HE (blast, heat and fragmentation)
• Protect missile silos from conventional HE (blast, heat and fragmentation)
• Protect underground stockpile from conventional HE (blast, heat and fragmentation)

Asset Level Protection – Passive – Cont.

Point - Structures Be Ahead
• Protect a building from high yield HE (blast, heat and fragmentation effects) from moving or stationary vehicles
• Protect a building from nuclear blast (shockwave, EMP, heat and radiation effects)
• Protect a building from DE
• Protect a building and internal C4I systems from EMP
• Protect a building from airborne CBRN contamination
• Protect a building from EO, electromagnetic and laser surveillance techniques
• Protect a hangar/storage facility from high yield HE (blast, heat and fragmentation effects)
• Protect a hangar/storage facility from nuclear blast (shockwave, EMP, heat and radiation effects)
• Protect a hangar/storage facility hangar from multi-stage penetrator weapon
• Protect a hangar/storage facility from corrosives
• Protect a C3/leadership node from high yield HE (blast, heat and fragmentation effects) from moving or stationary vehicle
• Protect a C3/leadership node from nuclear blast (shockwave, heat and radiation effects)
• Protect a C3/leadership node from DE
• Protect a C3/leadership node and internal C4I systems from EMP
• Protect a C3/leadership node from EO, electromagnetic and laser collection techniques
• Protect a C3/leadership node from electronic overload
• Protect underground bunker entry/exit points and air shafts from high yield HE (blast, heat and fragmentation effects)
• Protect a underground bunker entry/exit points from nuclear blast (shockwave, heat and radiation effects)
• Protect a underground bunker from multi-stage penetrator weapon
• Protect underground bunker C4I and power transmission links and nodes from EMP, electronic overload and short circuit
• Protect missile silos from high yield HE (blast, heat and fragmentation effects)
• Protect missile silos from nuclear blast (shockwave, EMP, heat and radiation effects)
• Protect missile silos from multi-stage penetrator weapon
• Protect underground bunker C4I and power transmission links and nodes from EMP, electronic overload and short circuit

Asset Level Protection – Passive – Cont.

Point - Structures **Be Ahead – Cont.**
• Protect underground stockpile from high yield HE (blast, heat and fragmentation effects)
• Protect underground stockpile from nuclear blast (shockwave, EMP, heat and radiation effects)

Point - Structures **Be Way Ahead**
• Protect a C3/leadership node from airborne biological/chemical contamination
• Protect a C3/leadership node from multi-stage penetrator weapon
• Protect underground bunker entry/exit points and air shafts from CBRN contamination
• Protect underground stockpile from multi-stage penetrator weapon

Asset Level Protection – Passive – Cont.

Area Neutral
• None

Area Equal
• Protect battlefield positions from HE (blast and fragmentation), projectiles, and DE with transportable fortifications (transportable shelters)
• Protect entry points from HE (blast and fragmentation) and Projectiles
• Protect entry point from moving vehicles with high speed/high strength stopping systems
• Protect communications links from electrical overload
• Protect communications links from compromising emanations
• Protect communications links from obtrusive (physical) taps
• Protect power transmission lines from electrical overload
• Protect power transmission lines from short circuit
• Protect energy production and transmission facilities from intrusion (unauthorized entry)
• Protect energy production and transmission facilities from forced entry tools

Area Be Ahead
• Protect battlefield positions from detection, observation and targeting with cover, concealment and deception (CCD)
• Protect battlefield maneuver and logistics routes from detection, observation and targeting with CCD
• Protect entry point from high yield HE
• Protect communications links from EW jamming
• Protect power transmission lines from conducting EMP (or, Protect power transmission components from EMP)
• Protect energy production and transmission facilities from high yield HE (blast, heat, fragmentation effects)
• Protect water supply from contamination

Asset Level Protection – Passive – Cont.

Area Be Way Ahead
• Protect underground stockpile from multi-stage penetrator weapon
• Protect blue force tracking signals from intercept, interpretation (geolocation), and exploitation
• Protect communications links from EMP (e.g., electronic bombs)

Asset Level Protection – Passive – Cont.

Information Systems Neutral
• None

Information Systems Equal
• None

Information Systems Be Ahead
• Protect against unauthorized access by uniquely identifying and authenticating each user
• Protect against false identification through unique and exclusive user and authentication mechanisms
• Protect against modification of user and authentication mechanisms
• Protect against spoofing of user and authentication mechanisms
• Protect against destruction of user and authentication mechanisms
• Protect against on-line and unauthorized access to network and computing boundaries
• Protect network and computing boundaries against on-line automated scanning tools
• Protect against by-pass of user authentication mechanisms
• Protect against introduction of trap doors or Trojan horses through positive control and object verification (checking)
• Protect privileged access to system administrator or root access through unique user and authentication mechanisms
• Protect against unauthorized change to access privileges (access name, access assignments, and need to know
• Protect against unauthorized access due to unpatched or misconfigured machines (enterprise CM configuration controls)
• Protect against unauthorized access due to pre-distribution access or code modification
• Protect against unauthorized access through wireless network nodes (entry through wireless injection via spoofing or false denial of involvement)
• Protect against unauthorized access through wireline network nodes (entry through wireline tap injection through spoofing or false denial of involvement)
• Protect against unauthorized access through web servers (and services) through user authentication and encryption

Asset Level Protection – Passive – Cont.

Information Systems **Be Ahead – Cont.**
• Protect against unauthorized access through web servers (and services) through server, server-to-server, and server-to-client (system to system vice user to system) authentication and encryption
• Protect against unauthorized access through firewalls
• Protect traceability of user action through non-destructive audit processes
• Protect traceability of computer component operations and transactions through non-destructive audit processes
• Protect traceability by preventing false denial of involvement (non-repudiation) of users
• Protect traceability by preventing false denial of involvement (non-repudiation) of computing components
• Protect against cyber sensor (sniffer) collections on computing node
• Protect against cyber sensor (sniffer) collections on network node
• Protect against cyber sensor (sniffer) collections on enterprise node
• Protect against cyber sensor (sniffer) collections through firewalls
• Protect against cyber sensor (sniffer) collections through cable modems
• Protect against cyber sensor (sniffer) output from compromised node
• Protect against distributed cyber sensor/attack with networked security tools
• Protect against insertion or initial execution of Trojan horses (or similar malicious code) with surveillance tools
• Protect against insertion or initial execution of Trojan horses (or similar malicious code) within firewalls
• Protect against insertion of malicious code through surveillance and filtering email
• Protect against collateral damage of computer network attack from spreading to data centers or similar back-up nodes
• Protect anti-virus software or filter modification or disablement by malicious code
• Protect against insertion of malicious code from software or data download sites through software integrity checkers
• Protect against insertion of malicious code from software or data download sites through authentication between computing nodes and download sites
• Protect against insertion of malicious code or data through FTP up-load spoofing or anonymous FTP file up-load
• Protect against distribution of multi-partite viruses on magnetic media

Asset Level Protection – Passive – Cont.

Information Systems **Be Way Ahead**
• Protect against unauthorized access through multi-level secure guard
• Protect against unauthorized access through multi-level secure system
• Protect against cyber sensor (sniffer) recruitment of network handlers
• Protect against distributed cyber sensor/attack

Pre-exposure

Air Neutral
• None

Air Equal
• Contain a chemical agent released as an aerosol, vapor, or liquid in the air
• Dilute a chemical agent released as an aerosol, vapor, or liquid in the air
• Control the drift of radioactive particles

Air Be Ahead
• Neutralize a chemical agent released as an aerosol, vapor, or liquid in the air
• Control the drift of a chemical agent released as a vapor or liquid in the air
• Kill a bacterial biological agent released as an aerosol in the air
• Kill a viral biological agent released as an aerosol in the air
• Neutralize a biological toxin released as an aerosol in the air
• Kill a rickettsial biological agent released as an aerosol in the air
• Kill a chlamydial biological agent released as an aerosol in the air
• Kill a fungal biological agent released as an aerosol in the air
• Contain a biological agent released as an aerosol in the air
• Control the drift of a biological agent released as an aerosol in the air
• Contain the radiation released from a radiological bomb

Air Be Way Ahead
• None

Pre-exposure – Cont.

Vector Neutral
• None

Vector Equal
• None

Vector Be Ahead
• Eliminate the vector of a bacterial biological agent
• Eliminate the vector of a viral biological agent
• Eliminate the vector of a biological toxin
• Eliminate the vector of a rickettsial biological agent
• Eliminate the vector of a chlamydial biological agent
• Eliminate the vector of a fungal biological agent

Vector Be Way Ahead
• None

Pre-exposure – Cont.

Water Neutral
• None

Water Equal
• Decontaminate water supply of a chemical or biological agent
• Decontaminate the water supply of radiation

Water Be Ahead
• None

Defeat Land Target Be Way Ahead
• None

Exposure

Exposure Neutral
• Rescue individuals from swift-water and blue-water
• Rescue individuals from extreme cold water and ice
• Rescue individuals from avalanche
• Rescue individuals from crevasses and trenches
• Rescue individuals from high-altitude locations
• Rescue individuals from confined spaces and industrial settings

Exposure Equal
• Perform networked and fully-integrated on-site triage to individuals exposed to a chemical agent
• Provide networked and fully-integrated on-site trauma care to individuals exposed to a chemical nerve agent
• Provide networked and fully-integrated on-site trauma care to individuals exposed to a chemical blister agent
• Provide networked and fully-integrated on-site trauma care to individuals exposed to a chemical blood agent
• Provide networked and fully-integrated on-site trauma care to individuals exposed to a chemical choking agent
• Administer on-site effective broad-spectrum antimicrobial therapy to individuals exposed to a bacterial biological agent that may be antibiotic resistant
• Administer on-site effective broad-spectrum antimicrobial therapy to individuals exposed to a rickettsial biological agent that may be antibiotic resistant
• Administer on-site effective broad-spectrum antimicrobial therapy to individuals exposed to a chlamydial biological agent that may be antibiotic resistant
• Administer on-site broad-spectrum anti-viral therapy to individuals exposed to a viral biological agent
• Administer on-site broad-spectrum anti-toxin therapy to individuals exposed to a toxic biological agent
• Provide rapid, on-site medical facilities that allow barrier-nursing, extended quarantine, and cohort care
• Quarantine individuals contaminated with biological agents
• Rapidly find affected individuals
• Perform networked and fully-integrated on-site triage
• Provide rapid, networked, and fully-integrated resuscitation and trauma

Exposure – Cont.

Exposure Equal – Cont.
• Protect individuals from nuclear fallout radiation
• Establish minimal treatment facilities that facilitate self-care while protecting from irradiation
• Decontaminate individual(s) of radiation
• Provide timely evacuation in reduced mobility environments
• Perform mass evacuation of critically injured personnel to appropriate care facility
• Perform mass evacuation of individuals from uncontaminated periphery of hot zone
• Perform mass evacuation of individuals from path of CBRN plume
• Perform mass evacuation of individuals from environments with minimal exits (buildings, subways)
• Create egress routes to enhance mass evacuation
• Rescue individuals from a chemical hot zone
• Rescue individuals from a radiological hot zone
• Rescue individuals from underwater entrapments
• Rescue individuals from collapsed structures or wreckage

Exposure – Cont.

Exposure Be Ahead
• Rapidly decontaminate fixed sites of biological or chemical agents with a non-toxic, non-corrosive, and environmentally friendly formulation that can be dispersed by a variety of methods
• Decontaminate small, sensitive equipment/items and components/parts of biological or chemical agents without harming their electronics and sensors
• Decontaminate interior spaces of aircraft and vehicles containing electronics of biological or chemical agents
• Decontaminate equipment and personnel during operations (on-the-move decontamination)
• Decontaminate skin/casualties with open wounds
• Decontaminate irradiated surfaces while radiation is loose

Exposure Be Way Ahead
• Perform networked and fully-integrated on-site triage to individuals
• Provide networked and fully-integrated on-site trauma care to individuals

Post-incident Response

Post-incident Response Neutral
• None

Post-incident Response Equal
• Perform simple, large surface-area, fixed radionuclide removal from external surfaces (to include sidewalks, building exteriors, streets, parks, sewage systems)
• Perform simple, large surface-area, fixed radionuclide removal from building interiors (to include walls and floors, carpeting, ducts)
• Perform simple, large surface-area, fixed radionuclide removal from infrastructure (to include transportation systems and water supplies)
• Provide extended, on-site, agent-specific antimicrobial therapy to individuals exposed to a bacterial biological agent that may be antibiotic resistant
• Provide extended, on-site, agent-specific antimicrobial therapy to individuals exposed to a rickettsial biological agent that may be antibiotic resistant
• Provide extended, on-site, agent-specific antimicrobial therapy to individuals exposed to a chlamydial biological agent that may be antibiotic resistant
• Provide extended, on-site, agent-specific anti-viral therapy to individuals exposed to a viral biological agent
• Provide extended, on-site, agent-specific anti-toxin therapy to individuals exposed to a toxic biological agent
• Reduce immunosuppression in mass casualty individuals resulting from irradiation

Post-incident Response Be Ahead
• None

Post-incident Response Be Way Ahead
• None

Platform Recovery (Damage Control)

Air **Neutral**
• None

Air **Equal**
• Automatically recover flight altitude and attitude in the absence of human control inputs
• Automatically recover/restore aircraft mission systems in event of power surge or loss
• Automatically terminate aircraft subsystem operation when catastrophic system anomaly is detected.

Air **Be Ahead**
• None

Air **Be Way Ahead**
• None

Platform Recovery (Damage Control) – Cont.

Sea Neutral
• None

Sea Equal
• Automatically repair and recover pressurization in a breached ship compartment
• Automatically repair and recover pressurization in a breached submarine compartment

Sea Be Ahead
• None

Sea Be Way Ahead
• None

Platform Recovery (Damage Control) – Cont.

Land Neutral
• None

Land Equal
• Automatically recover/restore vehicle mission systems in event of power surge or loss
• Automatically terminate vehicle subsystem operation when catastrophic system anomaly is detected

Land Be Ahead
• None

Land Be Way Ahead
• None

Platform Recovery (Damage Control) – Cont.

Space Neutral
• None

Space Equal
• Automatically recover satellite mission systems after power anomaly

Space Be Ahead
• None

Space Be Way Ahead
• None

Platform Recovery (Damage Control) – Cont.

Information Neutral
• None

Information Equal
• Recover and restore enterprise network configurations
• Recover and restore information (data)
• Recover and restore application software
• Recover and restore system configuration (network, software, and data) and automatically run diagnostics

Information Be Ahead
• None

Information Be Way Ahead
• None

APPENDIX B

CRITICAL TECHNOLOGIES FOR FORCE APPLICATION ORGANIZED BY BROAD INDUSTRIAL AREAS

(This page intentionally left blank.)

Acoustic Energy Weapons

Acoustic energy weapons—across the entire frequency spectrum, from infrasound to ultrasound—have the ability to cause severe pain, loss of bodily functions, and bodily injury. Depending on the frequencies, intensities (decibel level), and modulations employed, acoustic weapons could cause permanent or temporary physical damage, including damage to internal organs, interference with the workings of the central nervous system, and thermal injuries (burns). A host of military missions are being considered for acoustic weapons, including both battlefield combat and operations other than war—urban combat, crowd control, hostage rescue, perimeter defense, and physical security. They may also be capable of damaging or destroying underwater sensors, even submersed vehicle structures.

- Electro-Hydraulic Cavitation Device

Area Denial

Area denial weapons are used to prevent an adversary from occupying or traversing an area of land. The most common are land mines of various types. Mines are considered lethal defense, whereas non-lethal types include electrified barriers, sticky foams and millimeter wave active denial.

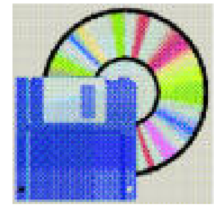
- Acoustic/IR Sniper Detection System
- Laser Air-Ionizing Stun Gun
- Non-Lethal Millimeter Wave Active Denial System
- Video Situational Analysis System

Armor	
Armor is defensive coverings designed to physically shield personnel or equipment from attack. This area includes both active and passive technologies.	

- Advanced Explosive Reactive
- Electrified Anti RPG
- Lightweight Armor Materials
- Lightweight Communications-Integrated Helmet
- Liquid Personnel Armor
- Smart Armor
- Space Hardening and Shielding
- Transparent Armor

Computer Network Defense (CND)

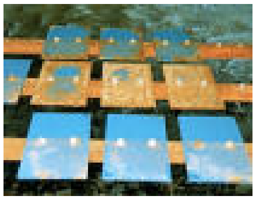
Computer Network Defense (CND) describes the actions taken to protect, monitor, analyze, detect, and respond to unauthorized activity within information systems and computer networks. CND protection activity employs information assurance principals and includes deliberate actions taken to modify an assurance configuration or condition in response to a CND alert or threat information.



- Anti-Spoofing Protocols and Systems
- Antivirus Software
- Biometric Authentication Technologies
- Computer Oracle and Password System (COPS)
- Configuration Management Software
- Content Security Software
- Fail-over Software
- Hardware Encryption Devices
- Heuristic Scanners
- High Degrees of Freedom Modem
- Hybrid Firewall
- Internet & Security Software
- Intrusion Detection Software
- Inventory Software
- Monitoring Software
- Multi-Level Secure System
- Network Authentication Protocols
- Network Protocol Analysis Software (Sniffer)
- Packet Switched Network
- Public Key Infrastructure
- RFID Tagging
- Secure Identity Management System
- Secure Sockets Layer
- Security Administration Analysis Tool
- Self-Regenerative Computer Network
- Signature Scanners
- Smart Card Authentication
- Sniffer Detection Software
- Token Authentication
- User Level Anomaly Detection System
- Vulnerability Scanning Software

Coatings

Coatings are any mixture of film-forming materials plus pigments, solvents, and other additives, which, when applied to a surface and cured or dried, yields a thin film that is functional. This broad industrial area includes coatings applied to assets to improve defensive properties, whether by strengthening armor or blast resistance, providing protection from laser or other weapons, reducing thermal or other signature, or achieving other protective effects.



- Anticorrosive
- Chemical Agent Resistant Coating (CARC) Paint
- Laser Reflective Coatings
- Rapidly Deployable Wall Retrofit

Conventional Weapons

Weapons that are neither, nuclear, biological, or chemical. The conventional weapons broad industrial area includes technologies that employ conventional guns or cannons to destroy threats such as cruise missiles, mines, rockets, torpedoes, artillery shells, mortar rounds, etc.

- Close-in Cannon Technology
- Extended Range Active SAM
- Extremely Fast-Reaction Fuse
- High-Energy Density Materials (HEDM)
- Medium-Range Active SAM
- Million-Rounds-Per-Minute Gun (Metal Storm)
- Radar Guided Anti-Air Artillery
- Rocket Launched Torpedo
- Rolling Airframe SAM
- Self-Fusing Artillery & Armor Munitions
- Self-Propagating High Temperature Synthesis (RF Pulse Effect)
- Short-Range Cruise Missile Interceptor (Missile)
- Thermobaric Explosives

Countermeasures

That form of military science that, by the employment of devices and/or techniques, has as its objective the impairment of the operational effectiveness of enemy activity. This broad technical area includes all precision guided weapon systems, electro-optical guided weapon systems, millimeter wave guided weapon systems, and related dispensable and non-dispensable countermeasures such as various flares, chaff, RF jamming, and sensor dazzling.

- Acoustic Towed Decoy
- Active Chaff
- Adaptive Track loops
- Advanced IR Target Discrimination Algorithms
- Air-Launched Decoys
- Air-to-Air Radar Jammer
- All Aspect and Shadow Shields
- Anti-Radiation Tether Retrofit
- Beamforming
- Cable-Based Magnetic Sweep Decoy
- Carrier Frequency Agility
- Catcher Netting
- Chaff
- Counter-IR Laser
- Counter-IR Multi-Band Laser
- Defensive Co-orbital "Escort" Sats
- Degausser
- Dialable Frequency Low-Power IR Transmitter/Jammer
- Dispersible IR Decoys
- Dispersible Kinematic Flare (AKA Smart Flare)
- Ejectable Obscurants
- Expendable Anti-Torpedo Acoustic Decoy
- Expendable RF Decoys
- Fiber Optic Towed Decoy
- Flares
- Gun-Launched Decoy
- Mobile, Re-Programmable Acoustic Decoy
- Non-Coherent Arc Lamps
- Nulling Antennas With Automatic Response
- Optical Limiters
- Optically-Generated RF Waveforms
- Plasma Antenna
- Radio Proximity Fuse Jammer
- Reduced RCS, Directional Laser IRCM System
- Selective-Reactive RF Jamming
- Self-Igniting Pyrotechnic Sources
- Ship-Launched Decoys
- Sidelobe Cancellation
- Space Frequency Adaptive Processing
- Space Launched Decoys
- Space Launched Radar Decoy
- Space LIRCM
- Spatial Temporal Adaptive
- Processing
- Supersonic Air Launch Kinetic Decoy
- Telescope Shades

Countermine	
Countermines are used to destroy or neutralize land or sea mines and are not covered under the directed energy weapons, conventional weapons, or kinetic energy weapons categories. This includes such technologies as mine sweeps, foam breech lanes, pulse generators, and mine ploughs.	

- Acoustic Shock via Chemical Explosive Arrays
- Acoustic Shock via Pulsed Power Array
- Acoustic Sweep
- Barrier Nets
- Chemical Mine Neutralization Systems
- Compact Towed Minesweeping System
- Expendable Magnetic Decoy
- Expendable Programmable Acoustic Decoy
- Explosive Channel Excavation
- Explosive Neutralization
- High-Power Pulse Generator
- High-Pressure Water Jet
- Highly Reactive Chemical Agents
- Magnetic Sweep
- Mine-Shredding Field Plough
- Multimode Sweep
- Petrochemical-Based Binary Compounds
- Rigid Polyurethane Foam
- Rocket-Deployed Line Charge Mine Clearing System
- Superconducting Magnetic Jamming/Sweeping
- Towed-Fabric Balloon Pressure Sweep

Decontaminants	
Decontaminants are materials that are used to make any person, object, or area safe by absorbing, destroying, neutralizing, making harmless, or removing chemical or biological agents, or by removing radioactive material clinging to or around it. This broad industrial area includes chemical agents and other technologies for the decontamination of personnel, equipment, or buildings that have been exposed to chemical or biological agents or radiation.	

- Capture Coating Passive Aerosol Generator
- CBR Washes and Sorbents
- Charcoal-Based Resin
- Chemical Agent-Degrading Bioengineered Enzymes
- Filtration Using Heat
- Filtration Using Ionization
- Filtration Using Oxidative Stress
- Filtration Using Ultraviolet Radiation
- Nano-Emulsion Spray
- Negative Air Flow
- Negative Pressure Enclosure
- Recirculating Solvent Wash
- Topical Skin Protectant/ Decontaminant
- Universal Containment System

Directed Energy Weapons	
Directed energy weapons are systems using directed energy primarily as a direct means to damage or destroy enemy equipment, facilities, and personnel. It is used to protect friendly equipment, facilities, and personnel to ensure friendly effective uses of the electromagnetic spectrum. This broad industrial area includes various laser and other directed energy weapon technologies that have defensive applications such as active defense against mines and missiles. It also includes enabling technologies such as relay mirrors and adaptive optics.	
♦ Adaptive Optics ♦ All-Gas Iodine Laser (AGIL). ♦ Atmospheric Compensation Deformable Mirror ♦ Beacon Illuminator Laser ♦ Chemical Oxygen Iodine Laser (COIL) ♦ Deuterium Flouride Laser ♦ Green Laser ♦ HF-Overtone Laser ♦ High-Power Fiber Laser ♦ High-Power Radio Frequency (HPRF) Weapons ♦ Hole-Boring Laser ♦ Low-Energy Laser ♦ Resonator Mirrors ♦ Solid State Electric Laser ♦ Space-Based Relay Mirror ♦ Spinning Plasma Toroid ♦ Target Illuminator Laser ♦ Tracking System for THEL	

Electronics Protection

Electronics protection is that division of electronics warfare involving passive and active means taken to protect personnel, facilities, and equipment from any effects of friendly or enemy employment of electronic warfare that degrade, neutralize, or destroy friendly combat capability. It includes technologies for hardening or insulating electronics against the effect of an electromagnetic pulse (EMP) or other forms of electronic attack.

- Adaptive Resource Management
- EMP Hardening
- Surge/EMP Suppression Technologies

Filters

Filters are devices or materials through which a gas or liquid is passed to separate out matter in suspension. It includes filter technologies to cleanse the air of harmful chemical or biological agents, as well as filter technologies that protect sensors or human eyes from lasers and other optical weapons.

- Advanced Portable Water Filtration Device
- High-Efficiency Particulate Air (HEPA) Filters
- Multiwave Laser Eye Protection
- Regenerative Chem-Bio Filtration
- Spectral Filter

Kinetic Energy Weapons	
A term describing hypervelocity projectile-type weapons used to destroy threats such as missiles, torpedoes, and mines.	

- 30mm Supercavitating – Supersonic Projectiles (SC-SSP)
- Brilliant Pebbles
- Combustion Light Gas Gun
- Co-orbital Interceptor (Space Mine)
- Direct Ascent (Pop-Up) Interceptor
- Kinetic Energy Interceptor (KEI)
- MEMS Rockets
- Miniaturization Technologies for Kill Vehicles
- Multiple Cooperative KKVs
- Slingatron

Materials	
Materials are substances, such as metals, ceramics, or plastics, used in building or construction under various conditions. It includes building or construction materials with improved protective characteristics (for example, materials for protection against high explosive or nuclear blast or penetrator weapons).	

- Blast and Energy Absorbing
- Dense Construction Materials
- Electrically Conductive Concrete
- Glass Fiber Reinforced Plastic
- High Strength, High Temperature Resistant
- Non-Metal Equipment
- Structure Strengthening

Pharmaceuticals

Pharmaceuticals are substances used in the diagnosis, treatment, or prevention of disease and for restoring, correcting, or modifying organic functions. In the context with Protection, it includes a variety of pharmaceuticals for inoculation against or recovery from chemical, biological, or radiation-related threats.

- Anthrax Vaccine
- Antifungal Agent
- Doxycycline
- Genetically Engineered Universal Inoculation
- Rickettsial Vaccine
- Smallpox Vaccine
- Synthetic Universal Blood Substitute

Propulsion

The propulsion industrial area is very board. It contains technologies for manned-rate, air-breathing propulsion systems to solid rocket motor technology for missiles. These propulsion systems power our aircraft, ships, weapons, and even our unmanned platforms. They are capable of moving our weapons systems at a few knots through the water or accelerate a vehicle to velocities that would allow flight to low earth orbit. In the context of Protection, it includes specialized propulsion technologies for ballistic missile defense.

- 3rd-Stage Rocket Motor for Interceptor
- Air Independent Submarine Propulsion
- Dual Pulse Rocket Motor for Interceptor
- High-Speed Torpedo Engine
- Rapid Acceleration Booster For Boost/Mid Course Interceptor
- Water Jets

<table>
<tr><th colspan="2">Robotics</th></tr>
<tr><td>Robotics is the design, construction, and use of machines (robots) to perform tasks done traditionally by human beings. In the context of Protection, it includes technologies that enable unmanned or autonomous protection missions such as robotic mine seekers and mine killers, among other technologies.</td><td></td></tr>
<tr><td colspan="2">

- Autonomous Mine Hunter-Killer
- Bio-Mimetic Technologies for AUVs
- Crawling UUVs
- Remotely-Piloted Mine Countermeasure (MCM) Vehicles
- Survivable, Hardened Hopping Robot
- UUV or Skimmer with Low-Cost Towed Array

</td></tr>
</table>

Signature Reduction

Signature reduction is the reduction of personal and equipment signature and it requires the minimizing/eliminating of sub-visible, visible, hyper-visible, electromagnetic, radio frequency, seismic, aural and olfactory signs to achieve the highest degree of signature management. Use of signature reduction technology can create conditions for unparalleled advantage over any potential adversary. It includes technologies for reducing the magnetic, acoustic, infrared, visual, or other signatures of a military asset. Examples of signature reduction technology include active magnetic signature reduction technologies, exhaust management systems, and vibration reduction technologies.

- Active Acoustic Cancellation
- Active Magnetic Signature Reduction System
- Adaptive Camouflage
- Advanced Thermal Exhaust Reduction
- Advanced Visual Exhaust Reduction
- Camouflage Screening Paint Patterns
- Composite Radar-Absorbing Materials
- Electromagnetic Shielding
- Engine Acoustic Insulation
- Exhaust Cooling
- Exhaust Management / Turning System
- Ground Vehicle Platform Noise Reduction
- IR Signature Control Coating
- Jitter and Vibration Control
- Laser Signature Reduction Coating
- Low-Observable Antennas
- Non-Magnetic Materials
- Optical Signature Reduction Coating
- Passive Acoustic Signature/ Noise Reduction System
- Passive Magnetic Signature Reduction
- Passive Vibration Isolation
- Radar Cross Section (RCS) Reducing/Absorbing Coating

Structures	
Structures are made up of the traditional material and structures technologies which form the backbone of our weapons platforms. Advanced material and structure will continue to be capability enablers. It includes structural design technologies that provide protection against threats, whether through reduced radar cross-section or improved structural strength.	
♦ Blast Barrier Walls ♦ Blast Doors ♦ Low-Observable Airframe ♦ Low-Observable Hullform ♦ Miniaturized Satellites/Nano-Satellites ♦ Monocoque Blast Resistant Design ♦ Rapidly Deployable Chem-Bio Protective Shelter	

Textiles	
Textiles are any filament, fibre, or yarn that can be made into fabric or cloth, and the resulting material itself. It includes textile technologies with protective characteristics such as resistance to chemical or biological agents, protection against radiation, multi-spectral camouflage, or health monitoring of the wearer.	

- CBR Head Protective Covering with Improved Voicemitter
- Chemical Protective Over-Garment Material
- Color Changing Fibers
- Cooling Undergarments
- Durable Protective Clothing
- Fireproof Overgarment Material
- Improved CBR Protective Gloves
- Insulated Garment Materials
- Lightweight IR Signature Reduction Clothing
- Multi-Spectral Camouflage Clothing
- Multi-Spectral Camouflage Cover
- Radar Transparent Garment Materials
- Self-Sealing Protective Garment
- Smart Uniform
- Tightly-Woven Fire-Proof Fabric
- Ultra-Lightweight Protective Suit

(This page intentionally left blank.)

APPENDIX C

A COMPENDIUM OF REPRESENTATIVE DEFENSE TECHNOLOGY SUPPLIERS WITH TRANSFORMATIONAL CAPABILITIES

NOTE: Companies listed are representative; the list is not exhaustive. Inclusion or exclusion does not imply future business opportunities with or endorsement by DoD.

C - 2

Technology Suppliers [1]						
Company Name	**Est.**	**Location**	**Employees**	**Sales (US$M)**	**Website**	**Technology / Line of Business**
Area Denial: Non-Lethal Millimeter Wave Active Denial System						
Air Force Research Laboratory (AFRL), Directed Energy Directorate	N/A	Kirtland Air Force Base, NM	600	$130.0	www.de.afrl.af.mil	Develop, integrate, and transition science and technology for directed energy including high power microwaves, lasers, adaptive optics, imaging, and effects
Raytheon AET	1922	Rancho Cucamonga, CA	75	$4.9	www.raytheon.com	Engineering services
Area Denial: Non-Lethal Millimeter Wave Active Denial System – Gyrotron Millimeter Wave Source						
Centre de Recherches en Physique des Plasmas	1961	Lausanne, Switzerland	135	N/A	crppwww.epfl.ch	Research and development in the fields of plasma physics and thermonuclear fusion
Communications and Power Industries (CPI) Microwave Power Products (MPP)	1995	Palo Alto, CA	1,490	$265.4	www.cpii.com	Broadcast and wireless components
Gycom, Ltd.	N/A	Nizhny Novgorod, Russia	N/A	N/A	N/A	Manufacture high power industrial and scientific gyrotrons
Gyrotron Technology, Inc.	1996	Bristol, PA	8	$1.2	www.gyrotrontech.com	Heat-treatment processing with microwave radiation generated in the form of a beam
Insight Product Company	1990	Brighton, MA	N/A	N/A	www.insight-product.com	Millimeter, sub-millimeter and IR sources and mixers
Thales, Electron Devices	2002	Ulm, Germany	370	$88.5	www.thales-electron-devices.de	Traveling Wave Tubes (TWTs)
Armor: Electrified Anti-RPG						
Battelle Memorial Institute	1929	Columbus, OH	16,000	$3,000.0	www.battelle.org	Research organization
Defense Science and Technology Laboratory	2001	Salisbury, U.K.	3,000	$636.6	www.dstl.gov.uk	Defense research and specialist technical services
Science Applications International Corporation (SAIC)	1969	Albuquerque, NM	42,700	$6,720.0	www.saic.com	Research and engineering company providing information technology, systems integration and eBusiness solutions
Armor: Lightweight Armor Materials						
Army Research Laboratory (ARL)	N/A	Adelphi, MD	N/A	N/A	www.arl.army.mil	Army's corporate laboratory
Honeywell Specialty Materials	1920	Morristown, NJ	11,000	$3,169.0	www.honeywell.com	Produce high-performance specialty materials products
Integran Technologies, Inc.	1999	Toronto, Canada	N/A	N/A	www.integran.com	Advanced metallurgical nano-technologies
MAGELLAN Systems International	1997	Richmond, VA	12	$0.7	www.m5fiber.com	Design and manufacture high strength fibers
Plasan Sasa	1982	Merom, Israel	10	$27.0	www.plasansasa.com	Development and manufacture of advanced composite add-on armor systems
Toyobo	N/A	Osaka, Japan	10,831	$3,531.4	www.toyobo.com	Fiber and textile manufacturing
Armor: Smart Armor						
Army Research Laboratory (ARL)	N/A	Adelphi, MD	N/A	N/A	www.arl.army.mil	Army's corporate laboratory
Ibis Tek	1996	Butler, PA	5	$3.7	www.ibistek.com	High tech security vehicles and systems
Production Products Manufacturing	1978	St. Louis, MO	156	$12.1	www.ppstl.net	Manufacture electronics, advanced composites, and engineered textiles

[1] **Companies listed are representative; the list is not exhaustive. Inclusion or exclusion does not imply future business opportunities with or endorsement by DoD.**

Sources: SEC Filings, Orbis Bureau van Dijk databases, RDS Business and Industry database, LexisNexis Academic Universe, S&P reports, Hoover's, US Major Companies Database, Yahoo Finance, US Business Directory, Dun & Bradstreet, and First Equity research.

Technology Suppliers [1]						
Company Name	**Est.**	**Location**	**Employees**	**Sales (US$M)**	**Website**	**Technology / Line of Business**
CND: Biometric Authentication Technologies						
Authentify, Inc.	1999	Chicago, IL	10	$0.3	www.authentify.com	Telephone-based identification software
Guardware Systems, Ltd.	1999	Budapest, Hungary	N/A	N/A	www.guardware.com	Fingerprint recognition biometric access management systems
Identix, Inc.	1982	Minnetonka, MN	480	$55.2	www.identix.com	Fingerprint, facial and skin biometric systems
Imagis Technologies, Inc.	1999	Vancouver, Canada	25	$1.0	www.imagistechnologies.com	Data integration technology and biometric facial recognition
Persay	2000	Tel Aviv, Israel	20	N/A	www.persay.com	Advanced biometric voice verification
Viisage	1996	Billerica, MA	126	$37.4	www.viisage.com	Biometric facial recognition
CND: Biometric Authentication Technologies – Face Recognition						
Acsys Biometrics	2003	Burlington, Canada	7	$0.6	www.acsysbiometrics.com	Facial recognition systems and other biometrics devices
Cognitec Systems	2001	Dresden, Germany	15	$2.6	www.cognitec-systems.de	Facial recognition software
IconQuest	N/A	Atlanta, GA	N/A	N/A	www.iconquesttech.com	Image recognition technology
Identix, Inc.	1982	Minnetonka, MN	480	$55.2	www.identix.com	Fingerprint, facial and skin biometric systems
Imagis Technologies, Inc.	1999	Vancouver, Canada	25	$1.0	www.imagistechnologies.com	Data integration technology and biometric facial recognition
Viisage	1996	Billerica, MA	126	$37.4	www.viisage.com	Biometric facial recognition
CND: Biometric Authentication Technologies – Fingerprint Scanners						
Aventura Technologies	2000	Hauppauge, NY	32	$4.2	www.aventruatechnologies.com/store/	Design and manufacture biometric authentication software and other security products
Fingerprint Cards	1997	Gothenburg, Sweden	20	$0.7	www.fingerprints.com	Biometric fingerprint sensor technology
Guardware Systems, Ltd.	1999	Budapest, Hungary	N/A	N/A	www.guardware.com	Fingerprint recognition biometric access management systems
Identix, Inc.	1982	Minnetonka, MN	480	$55.2	www.identix.com	Fingerprint, facial and skin biometric systems
SAFLINK Corporation	1991	Bellevue, WA	79	$2.0	www.saflink.com	Biometric authentication software
Smith Heimann Biometrics	1992	Jena, Germany	N/A	N/A	www.shb-jena.com	Design and manufacture digital imaging products for identification and document authentication
CND: Biometric Authentication Technologies – Iris Scanners						
LG Electronics U.S.A., Inc.	2002	Jamesburg, NJ	75	$388.3	www.lgiris.com	Iris technology recognition products
Panasonic U.S.A.	1918	Secaucus, NJ	N/A	N/A	www.panasonic.com	Design and manufacture consumer products, business products, semiconductors, and appliances
Retinal Technologies	N/A	Winchester, MA	4	N/A	www.retinaltech.com	Retinal biometric identification system
CND: Biometric Authentication Technologies – Voice Recognition						
Authentify, Inc	1999	Chicago, IL	10	$0.3	www.authentify.com	Telephone-based identification software
Persay	2000	Tel Aviv, Israel	20	N/A	www.persay.com	Advanced biometric voice verification
ScanSoft, Inc.	1999	Peabody, MA	806	$135.4	www.scansoft.com	Speech and imaging solutions
Vocent Solutions	N/A	Mountain View, CA	3	$0.1	www.vocent.com	Voice authentication software
VOICE.TRUST AG	2000	Munich, Germany	25	N/A	www.voicetrust.de	Biometric voice verification software
VoiceVault	1996	Dublin, Ireland	22	$1.5	www.voicevault.com	Biometric voice verification
CND: Heuristic Scanners						
ROSE Software Engineering	1988	Germany	9	N/A	come.to/rose_swe	Develops antivirus and security software

[1] **Companies listed are representative; the list is not exhaustive. Inclusion or exclusion does not imply future business opportunities with or endorsement by DoD.**

Sources: SEC Filings, Orbis Bureau van Dijk databases, RDS Business and Industry database, LexisNexis Academic Universe, S&P reports, Hoover's, US Major Companies Database, Yahoo Finance, US Business Directory, Dun & Bradstreet, and First Equity research.

Technology Suppliers [1]						
Company Name	**Est.**	**Location**	**Employees**	**Sales (US$M)**	**Website**	**Technology / Line of Business**
CND: Multi-Level Secure System						
DigiGAN	N/A	Stamford, CT	4	$0.4	www.digigan.com	Design network security systems
IBM	1923	White Plains, NY	255,157	$89,131.0	www.ibm.com	Computer hardware, software and semiconductors
iNetworks	1993	Seoul, Korea	50	$1.5	www.inetworks.co.kr	Network design and security solutions
Northrop Grumman	2000	Los Angeles, CA	122,600	$26,206.0	www.northropgrumman.com	Defense prime contractor and systems integrator
Thales	1968	Cedex, France	71,309	$1,761.3	www.thalesgroup.com	Global electronics company providing search, detection, navigation, guidance, aeronautical, and nautical systems
CND: RFID Tagging						
Applied Digital Solutions	1993	Delray Beach, FL	403	$95.3	www.adsx.com	Develop advanced technology for life sciences
Intermec Technologies Corp.	1966	Everett, WA	2,700	$706.6	www.intermec.com	Supply chain information systems
Precision Systems	N/A	Tel Aviv, Israel	N/A	N/A	www.precision-sys.com	Critical asset tracking system utilizing RFID tags
Royal Philips Electronics	1891	Amsterdam, The Netherlands	164,438	$36,505.0	www.philips.com	Products, systems and services in lighting, consumer electronics, domestic appliances and personal care, components, semiconductors and medical systems
Texas Instruments	1930	Dallas, TX	34,154	$9,834.0	www.ti.com	Digital signal processors and semiconductors
UPM Rafsec	1997	Tampere,	65	N/A	www.rafsec.com	RFID tags
Coatings: Laser Reflective Coatings						
Goodrich Corporation, Electro-Optical Systems	1870	Danbury, CT	550	$44.2	www.oss.goodrich.com	Design and manufacture electro-optical systems and sensors for aerospace and defense
Laser Components GmbH	1982	Olching, Germany	60	#VALUE!	www.lasercomponents.de	Coatings manufacturing
Northrop Grumman	2000	Los Angeles, CA	122,600	$26,206.0	www.northropgrumman.com	Defense prime contractor and systems integrator
Rockwell Scientific	2001	Thousand Oaks, CA	450	$33.7	www.rsc.rockwell.com	R&D in electronics, imaging sensors, information sciences, materials science, and optics
Sagem Groupe	1998	Paris, France	12,097	$3,991.5	www.sagem.com	Telecommunications and defense electronics
SLS Optics, Ltd.	1995	Isle of Man , U.K.	N/A	N/A	www.slsoptics.com	Manufacture Fabry-Perot etalons and optical coatings for the UV, visible and near IR spectrum
Conventional Weapons: Extended Range Active SAM						
EADS	1998	Schiphol Rijk, The Netherlands	109,135	$37,822.3	www.eads.com	Aerospace and defense conglomerate
Israeli Aircraft Industries	1953	Tel Aviv, Israel	14,500	$2,062.0	www.iai.co.il	Components, parts, and systems for military and commercial aerospace
Raytheon	1922	Waltham, MA	78,000	$18,109.0	www.raytheon.com	Defense and government electronics, space, information technology, technical services, and business aviation and special mission aircraft
Conventional Weapons: Extended Range Active SAM – Missile Propulsion						
Aerojet	1944	Sacramento, CA	2,700	$1,192.0	www.aerojet.com	Missile and space propulsion, and defense and armaments
Alliant Techsystems (ATK)	1990	Edina, MN	13,100	$2,366.2	www.atk.com	Propulsion, ordinance, and control systems and ammunition systems
China National Aero Technology Import and Export Corporation (CATIC)	1979	Beijing, China	2,000	$912.7	web.catic.com.cn	Import and Export of Aviation Products
EADS	1998	Schiphol Rijk, The Netherlands	109,135	$37,822.3	www.eads.com	Aerospace and defense conglomerate
Israeli Aircraft Industries	1953	Tel Aviv, Israel	14,500	$2,062.0	www.iai.co.il	Components, parts, and systems for military and commercial aerospace

[1] **Companies listed are representative; the list is not exhaustive. Inclusion or exclusion does not imply future business opportunities with or endorsement by DoD.**

Sources: SEC Filings, Orbis Bureau van Dijk databases, RDS Business and Industry database, LexisNexis Academic Universe, S&P reports, Hoover's, US Major Companies Database, Yahoo Finance, US Business Directory, Dun & Bradstreet, and First Equity research.

Technology Suppliers [1]						
Company Name	**Est.**	**Location**	**Employees**	**Sales (US$M)**	**Website**	**Technology / Line of Business**
Countermeasures: Dispersible Kinematic Flare						
BAE North America	1999	Rockville, MD	25,000	$5,000.0	www.baesystems.com	Design, manufacture, and maintenance of military aircraft, submarines, surface ships, avionics, radar, electronics, and weapons systems
Chemring Countermeasures	1997	Wiltshire, U.K.	1,641	$47.3	www.chemringcm.com	Design and manufacture range of RF and IR decoy cartridges for airborne, naval and land
Esterline Technologies	1967	Bellevue, WA	5,500	$562.5	www.esterline.com	Elastomer products, ordnance, and military countermeasures
Kilgore Flares Company	1925	Toone, TN	375	$40.7	www.chemring.co.uk	Conventional IR decoys
Thales	1968	Cedex, France	71,309	$1,761.3	www.thalesgroup.com	Global electronics company providing search, detection, navigation, guidance, aeronautical, and nautical systems
Countermeasures: Mobile, Re-programmable Acoustic Decoy						
BAE Underwater Systems	1984	Waterlooville, U.K.	570	N/A	www.baesystems.com	Development and produce undersea guided weapons, unmanned vehicles, mine warfare systems and diver reconnaissance aids
Northrop Grumman	2000	Los Angeles, CA	122,600	$26,206.0	www.northropgrumman.com	Defense prime contractor and systems integrator
Office of Naval Research (ONR)	1946	Arlington, VA	N/A	N/A	www.onr.navy.mil	Coordinate, execute, and promote the science and technology programs of the US Navy
Rafael Underwater and Surface Warfare Systems	1948	Haifa, Israel	5,000	$804.3	www.rafael.co.il	Defense R&D of microelectronics, communications, acoustics, and propulsion
Sensytech, Inc.	1998	Newington, VA	220	$53.2	www.sensytech.com	Manufacture electronic high frequency communications systems and components
Countermeasures: Plasma Antenna						
ASI Technology	1999	Henderson, NV	3	$0.0	www.asiplasma.com	Development and commercialization of plasma technologies
Defence Science and Technology Organization	1910	Melbourne, Australia	N/A	N/A	www.dsto.defence.gov.au	Australia's government defense research facilities
Haleakala Research & Development	2002	Brookfield, MA	2	$0.1	www.haleakala-research.com	Develop plasma smart antennas
Markland Technologies	2002	Ridgefield, CT	30	$10.0	www.marklandtech.com	Biometric devices and security systems integration
ONERA (French Aeronautics & Space Research Center)	1946	Chatillon, France	1,850	$125.4	www.onera.fr	Aircraft, spacecraft and missile design
Plasma Antennas Ltd.	2000	Oxford, England	4	$0.0	www.plasmaantennas.com	Plasma antennas
Countermeasures: Plasma Antenna - Non-Metallic Substrates						
Antenova	1999	Cambridge, U.K.	33	$0.0	www.antenova.com	Design and manufacture antennas
Honeywell Electronic Materials	1961	Sunnyvale, CA	N/A	N/A	www.honeywell.com/sites/sm/em	Develop and manufacture chemicals and specialty materials used in the production of semiconductors
Isola Laminate Systems Corp	1945	Chandler, AZ	2,200	$169.4	www.isola-usa.com	Manufacture base materials for circuit boards
Kyocera Corporation	1959	Shiga, Japan	57,870	$10,969.4	www.kyocera.com	Manufacture components and fine ceramic products for the electronics industry
M/A-COM	1950	Lowell, MA	3,000	N/A	www.macom.com	Develop and manufacture radio frequency (RF) and microwave semiconductors, components and IP network solutions
Microface Co., Ltd	1999	Gyeonggi-do, Republic of Korea	N/A	N/A	www.mface.com	High-end and technically advanced antenna

[1] **Companies listed are representative; the list is not exhaustive. Inclusion or exclusion does not imply future business opportunities with or endorsement by DoD.**

Sources: SEC Filings, Orbis Bureau van Dijk databases, RDS Business and Industry database, LexisNexis Academic Universe, S&P reports, Hoover's, US Major Companies Database, Yahoo Finance, US Business Directory, Dun & Bradstreet, and First Equity research.

Technology Suppliers [1]						
Company Name	**Est.**	**Location**	**Employees**	**Sales (US$M)**	**Website**	**Technology / Line of Business**
Countermeasures: Plasma Antenna – Switch Backplanes						
APW	2000	Waukesha, WI	5,000	$663.0	www.apw.com	Design and manufacture enclosures for electronic systems
Comtel	N/A	Basingstoke, U.K.	N/A	N/A	www.comtel-online.com	Design and manufacture backplanes, sub-racks and integrated enclosures
ERNI	1947	Zurich, Switzerland	N/A	N/A	www.erni.com	Electronic connectors and backplane assembly
Hartmann Elektronik	1971	Stuttgart, Germany	3,800	$406.4	www.hartmann-elektronik.de	Develop and produce backplanes
National Semiconductor	1959	Santa Clara, CA	9,700	$1,983.1	www.national.com	Manufacture semiconductors and analog integrated circuits
Tracewell Systems	N/A	Westerville, OH	225	$14.0	www.tracewellsystems.com	System engineering services for design, power control, thermal management, backplanes and manufacturing
Countermeasures: Selective-Reactive RF Jamming						
Northrop Grumman	2000	Los Angeles, CA	122,600	$26,206.0	www.northropgrumman.com	Defense prime contractor and systems integrator
Rockwell Collins	2003	Cedar Rapids, IA	14,950	$2,542.0	www.rockwellcollins.com	Design, production and support of communications and aviation electronics
Thales	1968	Cedex, France	71,309	$1,761.3	www.thalesgroup.com	Global electronics company providing search, detection, navigation, guidance, aeronautical, and nautical systems
Countermeasures: Expendable Programmable Acoustic Decoy						
ADI Limited	1989	Garden Island NSW, Australia	2,500	$524.3	www.adi-limited.com	Australia's leading defense, engineering and systems contractor
EDO Corp., Electro-Ceramic Products	1958	Salt Lake City, UT	N/A	N/A	www.edoceramic.com	Piezoelectric materials and ceramic based products for aerospace and defense
Kongsberg Defence and Aerospace AS	1997	Kongsberg, Norway	1,150	$246.3	www.kongsberg.com	Anti-ship missiles, command and control systems, and communications
Rafael Armament Development Authority, Ltd.	1948	Tel Aviv, Israel	5,000	$804.3	www.rafael.co.il	Defense R&D of microelectronics, communications, acoustics, and propulsion
Sensytech, Inc.	1998	Newington, VA	220	$53.2	www.sensytech.com	Manufacture electronic high frequency communications systems and components
Sippican, Inc.	1940	Marion, MA	300	$66.0	www.sippican.com	Naval electronics systems
Countermine: Rigid Polyurethane Foam						
BASF Aktiengesellschaft (AG)	1865	Ludwigshafen, Germany	87,000	$41,922.9	www.basf.com	Chemical production
FoamSpray	N/A	Leeds, U.K.	N/A	N/A	www.foamspray.co.uk	Polyurethane foam spray-on insulation system
General Plastics Manufacturing Company	1941	Tacoma, WA	134	$17.5	www.generalplastics.com	Manufacture plastic foam products
North Carolina Foam Industries	1964	Mount Airy, NC	165	$9.5	www.ncfi.com	Formulate and manufacture foam-in-place polyurethane foam systems
Tosoh Corporation	1935	Tokyo, Japan	9,196	$4,585.2	www.tosoh.com	Manufacture industrial and specialty chemicals
UCSC	1979	Phoenix, AZ	34	$17.0	www.ucscurethane.com	Manufacture plastic foam products and protective coatings

[1] **Companies listed are representative; the list is not exhaustive. Inclusion or exclusion does not imply future business opportunities with or endorsement by DoD.**

Sources: SEC Filings, Orbis Bureau van Dijk databases, RDS Business and Industry database, LexisNexis Academic Universe, S&P reports, Hoover's, US Major Companies Database, Yahoo Finance, US Business Directory, Dun & Bradstreet, and First Equity research.

Technology Suppliers [1]						
Company Name	**Est.**	**Location**	**Employees**	**Sales (US$M)**	**Website**	**Technology / Line of Business**
Countermine: Towed Fabric Balloon Pressure Sweep						
Canflex USA, Inc.	1975	Anacortes, WA	10	$4.0	www.canflexinc.com	Manufacture welded products made form coated high strength polyester, nylon, and Kevlar fabrics
Defence Science and Technology Organization	1910	Pyrmont NSW, Australia	N/A	N/A	www.dsto.defence.gov.au	Australia's government defense research facilities
Dunlop Fabrications	N/A	Manchester, UK	N/A	N/A	www.dunlopgrg.co.uk	Manufacture specialized rubber products
Para-Anchors Australia, Pty	1990	Victoria, Australia	3	$0.1	www.paraanchors.com.au	Parachute sea anchor
Decontaminants: Chemical-Agent-Degrading Bioengineered Enzymes						
Agave BioSystems	1998	Austin, TX	15	$1.0	www.agavebio.com	Nanoscale biological systems
U.S. Army Edgewood Chemical Biological Center	1917	Edgewood, MD	1,050	$382.5	www.ecbc.army.mil	Research and development center for chemical and biological defense
Walter Reed Army Institute of Research	1893	Silver Spring, MD	N/A	N/A	wrair-www.army.mil	Biomedical military research laboratory
Decontaminants: Topical Skin Protectant/Decontaminant						
DFB Pharmaceuticals	1992	San Antonio, TX	220	$90.4	www.dfb.com	Manufacture pharmaceutical preparations
Emory University	1836	Atlanta, GA	2,500	N/A	www.ott.emory.edu	Major University
NanoScale	1995	Manhattan, KS	30	$3.1	www.nanmatinc.com	Develop nanochemistry-based products
O'Dell Engineering Ltd.	1995	Ontario, Canada	N/A	N/A	www.odel.on.ca	Chemical and biological decontamination products
U.S. Army Medical Research Institute of Chemical Defense	N/A	Aberdeen, MD	N/A	N/A	ccc.apgea.army.mil	Develop medical countermeasures to chemical warfare agents and train medical personnel
Directed Energy Weapons: Laser Relay Mirror						
Air Force Research Laboratory (AFRL), Directed Energy Directorate	N/A	Kirtland Air Force Base, NM	600	$130.0	www.de.afrl.af.mil	Develop, integrate, and transition science and technology for directed energy including high power microwaves, lasers, adaptive optics, imaging, and effects
Ball Aerospace & Technologies Corp.	1995	Broomfield, CO	2,750	$491.0	www.ball.com	Design and manufacture imaging, communications, and information systems for aerospace
Boeing, Laser & Electro-Optic Systems	N/A	Canoga Park, CA	N/A	N/A	www.boeing.com	Research and development in directed energy technologies
Directed Energy Weapons: Laser Relay Mirror – Control System						
ABB Automation Technologies, Inc.	1988	Quebec, Canada	55,000	$18,795.0	www.abb.com	Power and automation technologies
Air Force Research Laboratory (AFRL), Directed Energy Directorate	N/A	Kirtland Air Force Base, NM	600	$130.0	www.de.afrl.af.mil	Develop, integrate, and transition science and technology for directed energy including high power microwaves, lasers, adaptive optics, imaging, and effects
Alcatel Space	1898	Paris, France	5,291	$1,185.1	www.alcatel.com	Develops satellite technology for telecommunications, navigation, optical and radar observation, meteorology, and sciences
Blue Line Engineering	1994	Colorado Springs, CO	5	$0.3	www.bluelineengineering.com	Differential position sensors, actuators, and optical control systems
Goodrich Corporation, Electro-Optical Systems	1870	Danbury, CT	550	$44.2	www.oss.goodrich.com	Design and manufacture electro-optical systems and sensors for aerospace and defense
Kaman Measuring Systems	1945	Middletown, CT	N/A	N/A	www.kamansensors.com	High-performance, precision non-contact position measuring systems
Vibro-Meter, SA	1952	Fribourg, Switzerland	450	N/A	www.vibro-meter.ch	Vibration monitoring systems and sensors

[1] **Companies listed are representative; the list is not exhaustive. Inclusion or exclusion does not imply future business opportunities with or endorsement by DoD.**

Sources: SEC Filings, Orbis Bureau van Dijk databases, RDS Business and Industry database, LexisNexis Academic Universe, S&P reports, Hoover's, US Major Companies Database, Yahoo Finance, US Business Directory, Dun & Bradstreet, and First Equity research.

Technology Suppliers [1]						
Company Name	**Est.**	**Location**	**Employees**	**Sales (US$M)**	**Website**	**Technology / Line of Business**
Directed Energy Weapons: Laser Relay Mirror – Mirrors/Optics						
Air Force Research Laboratory (AFRL), Directed Energy Directorate	N/A	Kirtland Air Force Base, NM	600	$130.0	www.de.afrl.af.mil	Develop, integrate, and transition science and technology for directed energy including high power microwaves, lasers, adaptive optics, imaging, and effects
Boeing, Laser & Electro-Optic Systems	N/A	Canoga Park, CA	N/A	N/A	www.boeing.com	Research and development in directed energy technologies
Goodrich Corporation, Electro-Optical Systems	1870	Danbury, CT	550	$44.2	www.oss.goodrich.com	Design and manufacture electro-optical systems and sensors for aerospace and defense
Electronics Protection: EMP Hardening						
BAE Systems, Advanced Systems	N/A	Greenlawn, NY	120	$36.0	www.as.na.baesystems.com	Design and manufacture defense electronics equipment and systems
Harris Corporation	1926	Melbourne, FL	10,900	$2,518.6	www.harris.com	Microwave, satellite, and other wireless network transmission equipment; air traffic control systems; mobile radio systems; and digital network broadcasting and management systems
Holland Shielding Systems	1985	Dordrecht, Netherlands	N/A	N/A	www.hollandshielding.com	Manufacture EMI/RFI shielding products
Sandia National Laboratory	1949	Albuquerque, NM	8,600	N/A	www.sandia.gov	Multi-program laboratory, primarily doing national defense R&D, energy, and environment projects
Electronics Protection: EMP Hardening – EMP-Hardened Semiconductors						
Aeroflex	1937	Colorado Springs, CO	2,398	$414.1	www.aeroflex.com	Design, engineering, manufacturing, production and sales of microelectronic and test solutions
Harris Corporation	1926	Melbourne, FL	10,900	$2,518.6	www.harris.com	Microwave, satellite, and other wireless network transmission equipment; air traffic control systems; mobile radio systems; and digital network broadcasting and management systems
Sandia National Laboratory	1949	Albuquerque, NM	8,600	N/A	www.sandia.gov	Multi-program laboratory, primarily doing national defense R&D, energy, and environment projects
Electronics Protection: EMP Hardening – EMP Metallic Shielding						
BAE Systems, Advanced Systems	N/A	Greenlawn, NY	120	$36.0	www.as.na.baesystems.com	Design and manufacture defense electronics equipment and systems
Holland Shielding Systems	1985	Dordrecht, Netherlands	N/A	N/A	www.hollandshielding.com	Manufacture EMI/RFI shielding products
Laird Technologies	1864	Delaware Water Gap, PA	N/A	N/A	www.lairdtech.com	Manufacture electromagnetic interference (EMI) shielding materials
Sigma Technologies International, Inc.	N/A	Tucson, AZ	37	$6.4	www.sigmalabs.com	Treatment and coating technologies for fictionalization of material surfaces
Filters: Multiwave Laser Eye Protection						
Commonwealth Scientific & Industrial Research Organization	1926	Dickson, Australia	6,600	$206.3	www.csiro.au	Research organization
DRS Technologies	1969	Parsippany, NY	5,800	$1,001.3	www.drs.com	Defense systems manufacturer
Gentex Corporation	1932	Carbondale, PA	575	$60.5	www.gentexcorp.com	Manufacture military helmets
Rockwell Scientific	2001	Thousand Oaks, CA	450	$33.7	www.rsc.rockwell.com	R&D in electronics, imaging sensors, information sciences, materials science, and optics

[1] **Companies listed are representative; the list is not exhaustive. Inclusion or exclusion does not imply future business opportunities with or endorsement by DoD.**

Sources: SEC Filings, Orbis Bureau van Dijk databases, RDS Business and Industry database, LexisNexis Academic Universe, S&P reports, Hoover's, US Major Companies Database, Yahoo Finance, US Business Directory, Dun & Bradstreet, and First Equity research.

Technology Suppliers [1]						
Company Name	**Est.**	**Location**	**Employees**	**Sales (US$M)**	**Website**	**Technology / Line of Business**
Filters: Regenerative Chemical-Biological Filtration						
Ametek Airtechnology Group	1986	Sunbury on Thames, U.K.	239	$43.0	www.aircontroltechnologies.co.uk	Design and manufacture specialized fans and electromechanical components and systems for aerospace and defense
Domnick Hunter Group, plc	1963	Durham, U.K.	1,449	$243.4	www.domnickhunter.com	Design and manufacture filtration, separation and purification products
Pall Aerospace	1946	Portsmouth, U.K.	N/A	$178.1	www.pall.com	Manufacture filtration equipment for aerospace and defense industry
Paragon Space Development Corporation (SDC)	1993	Tucson, AZ	10	$0.9	www.paragonsdc.com	Aerospace engineering and life support system design
Kinetic Energy Weapons: 30-mm Supercavitating – Supersonic Projectiles (SC-SSP)						
Alliant Techsystems (ATK)	1990	Edina, MN	13,100	$2,366.2	www.atk.com	Propulsion, ordinance, and control systems and ammunition systems
C Tech Defense Corporation	N/A	Port Angeles, WA	N/A	N/A	www.ctechdefense.com	Aero-ballistics, hydrodynamics, and directed energy devices
Directorate of Research, Studies and Techniques	N/A	France	N/A	N/A	N/A	French government research laboratories
Northrop Grumman	2000	Los Angeles, CA	122,600	$26,206.0	www.northropgrumman.com	Defense prime contractor and systems integrator
Kinetic Energy Weapons: Kinetic Energy Interceptor (KEI)						
Alenia Spazio	1990	Rome, Italy	2,400	N/A	www.aleniaspazio.it	Design and manufacture space systems
BAE Systems	1977	Bristol, United Kingdom	68,400	$14,911.2	www.baesystems.com	Designs, manufactures, and supports military aircraft, surface ships, submarines, space systems, radar, avionics, C4ISR, electronic systems
Boeing Integrated Defense Systems	1934	St. Louis, MO	78,000	$27,361.0	www.boeing.com	Weapons and aircraft capabilities, intelligence and surveillance systems, communications architectures and extensive large-scale integration expertise
EADS	1998	Amsterdam, Netherlands	109,135	$37,822.3	www.eads.com	Aerospace and defense conglomerate
Lockheed Martin	1994	Bethesda, MD	130,000	$31,824.0	www.lockheedmartin.com	Design, manufacture, and integrate advanced technology products
Northrop Grumman	2000	Los Angeles, CA	122,600	$26,206.0	www.northropgrumman.com	Defense prime contractor and systems integrator
Raytheon	1922	Waltham, MA	78,000	$18,109.0	www.raytheon.com	Defense and government electronics, space, information technology, technical services, and business aviation and special mission aircraft
Kinetic Energy Weapons: Kinetic Energy Interceptor (KEI) – Booster						
Aerojet	1944	Sacramento, CA	2,700	$1,192.0	www.aerojet.com	Missile and space propulsion, and defense and armaments
Alliant Techsystems (ATK), Tactical Systems	N/A	Elkton, MD	350	$25.6	www.atk.com	Propulsion, ordinance, and control systems and ammunition systems
BAE Systems	1977	Bristol, United Kingdom	68,400	$14,911.2	www.baesystems.com	Designs, manufactures, and supports military aircraft, surface ships, submarines, space systems, radar, avionics, C4ISR, electronic systems
EADS	1998	Amsterdam, Netherlands	109,135	$37,822.3	www.eads.com	Aerospace and defense conglomerate
Orbital Sciences Corporation	1982	Chandler, AZ	2,160	$581.5	www.orbital.com	Small space and rocket systems

[1] **Companies listed are representative; the list is not exhaustive. Inclusion or exclusion does not imply future business opportunities with or endorsement by DoD.**
Sources: SEC Filings, Orbis Bureau van Dijk databases, RDS Business and Industry database, LexisNexis Academic Universe, S&P reports, Hoover's, US Major Companies Database, Yahoo Finance, US Business Directory, Dun & Bradstreet, and First Equity research.

Technology Suppliers [1]						
Company Name	**Est.**	**Location**	**Employees**	**Sales (US$M)**	**Website**	**Technology / Line of Business**
Kinetic Energy Weapons: Kinetic Energy Interceptor (KEI) – Kill Vehicle						
BAE Systems	1977	Bristol, United Kingdom	68,400	$14,911.2	www.baesystems.com	Designs, manufactures, and supports military aircraft, surface ships, submarines, space systems, radar, avionics, C4ISR, electronic systems
Boeing Integrated Defense Systems	1934	St. Louis, MO	78,000	$27,361.0	www.boeing.com	Weapons and aircraft capabilities, intelligence and surveillance systems, communications architectures and extensive large-scale integration expertise
EADS	1998	Amsterdam, Netherlands	109,135	$37,822.3	www.eads.com	Aerospace and defense conglomerate
Lockheed Martin	1994	Bethesda, MD	130,000	$31,824.0	www.lockheedmartin.com	Design, manufacture, and integrate advanced technology products
Raytheon	1922	Waltham, MA	78,000	$18,109.0	www.raytheon.com	Defense and government electronics, space, information technology, technical services, and business aviation and special mission aircraft
Thales	1968	Cedex, France	71,309	$1,761.3	www.thalesgroup.com	Global electronics company providing search, detection, navigation, guidance, aeronautical, and nautical systems
Kinetic Energy Weapons: Miniaturization Technologies for Kill Vehicles						
BAE Systems	1977	Bristol, United Kingdom	68,400	$14,911.2	www.baesystems.com	Designs, manufactures, and supports military aircraft, surface ships, submarines, space systems, radar, avionics, C4ISR, electronic systems
Davidson Technologies	1996	Huntsville, AL	130	$22.6	www.davidson-tech.com	Technical management consulting
EADS	1998	Amsterdam, Netherlands	109,135	$37,822.3	www.eads.com	Aerospace and defense conglomerate
L-3 Coleman Aerospace	N/A	Orlando, FL	150	$9.0	www.crc.com	Missile systems engineering
Lockheed Martin Space Systems	N/A	Sunnyvale, CA	6,000	$647.3	www.lockheedmartin.com	Production and integration of launch vehicles and systems
Thales	1968	Cedex, France	71,309	$1,761.3	www.thalesgroup.com	Global electronics company providing search, detection, navigation, guidance, aeronautical, and nautical systems
Kinetic Energy Weapons: Miniaturization Technologies for Kill Vehicles – Miniaturized Divert & Attitude Control System						
Aerojet	1944	Sacramento, CA	2,700	$1,192.0	www.aerojet.com	Missile and space propulsion, and defense and armaments
Alliant Techsystems (ATK), Tactical Systems	N/A	Elkton, MD	350	$25.6	www.atk.com	Propulsion, ordinance, and control systems and ammunition systems
Boeing Rocketdyne Propulsion and Power	1955	Canoga Park, CA	N/A	N/A	www.boeing.com	Design and development propulsion systems
EADS	1998	Amsterdam, Netherlands	109,135	$37,822.3	www.eads.com	Aerospace and defense conglomerate
Snecma Group	1905	Paris, France	35,609	$68,168.0	www.snecma.com	Aircraft and rocket propulsion, equipment and associated services
Thales	1968	Cedex, France	71,309	$1,761.3	www.thalesgroup.com	Global electronics company providing search, detection, navigation, guidance, aeronautical, and nautical systems

[1] **Companies listed are representative; the list is not exhaustive. Inclusion or exclusion does not imply future business opportunities with or endorsement by DoD.**

Sources: SEC Filings, Orbis Bureau van Dijk databases, RDS Business and Industry database, LexisNexis Academic Universe, S&P reports, Hoover's, US Major Companies Database, Yahoo Finance, US Business Directory, Dun & Bradstreet, and First Equity research.

Technology Suppliers [1]						
Company Name	**Est.**	**Location**	**Employees**	**Sales (US$M)**	**Website**	**Technology / Line of Business**
Kinetic Energy Weapons: Miniaturization Technologies for Kill Vehicles – Miniaturized GNC System						
BEI Technologies, Systron Donner Inertial Division	1997	Concord, CA	200	$18.9	www.systron.com	Supplier of mature solid-state quartz based inertial sensors and subsystems
Draper Laboratories	1973	Cambridge, MA	1,025	N/A	www.draper.com	Research laboratory for guidance, navigation, and control systems
EADS	1998	Amsterdam, Netherlands	109,135	$37,822.3	www.eads.com	Aerospace and defense conglomerate
Magellan Aerospace Corp.	1996	Mississauga, Canada	3,000	$548.0	www.magellanaerospace.com	Design and manufacture aeroengine and aerostructure components and advanced military and space products
Milli Sensor System & Actuators (MSSA)	N/A	West Newton, MA	13	$0.9	www.mssainc.com	Research and develop MEMS gyros, accelerometers, and systems
Thales	1968	Cedex, France	71,309	$1,761.3	www.thalesgroup.com	Global electronics company providing search, detection, navigation, guidance, aeronautical, and nautical systems
Kinetic Energy Weapons: Miniaturization Technologies for Kill Vehicles – Miniaturized Seekers						
BAE Systems	1977	Bristol, United Kingdom	68,400	$14,911.2	www.baesystems.com	Designs, manufactures, and supports military aircraft, surface ships, submarines, space systems, radar, avionics, C4ISR, electronic systems
EADS	1998	Amsterdam, Netherlands	109,135	$37,822.3	www.eads.com	Aerospace and defense conglomerate
Lockheed Martin	1994	Bethesda, MD	130,000	$31,824.0	www.lockheedmartin.com	Design, manufacture, and integrate advanced technology products
Pacific Advanced Technology	1988	Santa Ynez, CA	6	N/A	www.patinc.com	Imaging spectrometers
Sarnoff Corporation	1942	Princeton, NJ	530	$100.0	www.sarnoff.com	Contract research in electronics, biomedicine, and information technology
Thales	1968	Cedex, France	71,309	$1,761.3	www.thalesgroup.com	Global electronics company providing search, detection, navigation, guidance, aeronautical, and nautical systems
Materials: Blast and Energy Absorbing						
Cymat Corp.	1990	Ontario, Canada	42	$0.2	www.cymat.com	Design and manufacture of stabilizing aluminum foam
FIREXX Corporation	1997	Riyadh, Saudi Arabia	N/A	N/A	www.firexx.com	Ultra-thin, yet strong, expanded alloy foil "mesh" used for blast mitigation and fire mitigation
General Plastics Manufacturing Company	1941	Tacoma, WA	134	$17.5	www.generalplastics.com	Manufacture plastic foam products
Mandall Armor Design and Manufacturing, Inc.	1990	Phoenix, AZ	15	$1.4	www.mandall.com	Develop and manufacture armor and security products
Massachusetts Institute of Technology, Institute for Soldier Nanotechnologies	N/A	Cambridge, MA	N/A	N/A	www.mit.edu	Major University

[1] **Companies listed are representative; the list is not exhaustive. Inclusion or exclusion does not imply future business opportunities with or endorsement by DoD.**

Sources: SEC Filings, Orbis Bureau van Dijk databases, RDS Business and Industry database, LexisNexis Academic Universe, S&P reports, Hoover's, US Major Companies Database, Yahoo Finance, US Business Directory, Dun & Bradstreet, and First Equity research.

Technology Suppliers [1]						
Company Name	**Est.**	**Location**	**Employees**	**Sales (US$M)**	**Website**	**Technology / Line of Business**
Materials: Glass Fiber Reinforced Plastic						
Danyard Aalborg	1987	Aalborg, Denmark	350	$30.7	www.navalyard.dk	Composites material shipbuilding
General Dynamics Armament and Technical Products	2002	Charlotte, NC	2,400	$202.6	www.gdarm.com	Design and manufacture armament systems, composite products for aerospace , biological and chemical detection systems, and sensor systems
Intermarine, SpA	1887	Sarzana, Italy	N/A	N/A	www.rodriguez.it	Naval shipyard specialized in Fiber Reinforced Plastic marine craft
Seemann Composites, Inc.	1987	Gulfport, MS	43	$2.3	www.seemanncomposites.com	Advanced composite structures and products fabrication
Swiftships, LLC	1969	Morgant City, LA	300	$11.0	www.swiftships.com	international mid-size ship design and shipbuilding company
Vosper Thornycroft	1966	Southampton, U.K.	10,000	$757.1	www.vosperthornycroft.co.uk	Shipbuilding and manufacturing of motion controls, sensors, and power management systems
Pharmaceuticals: Synthetic Universal Blood Substitute						
Alliance Pharmaceutical	1989	San Diego, CA	7	$0.5	www.allp.com	Pharmaceutical research and development
Hemosol Corporation	1985	Ontario, Canada	140	$0.0	www.hemosol.com	Develop and manufacture biologics, particularly blood-related proteins
Sanguine Corporation	N/A	Pasadena, CA	3	$0.0	www.sanguine-corp.com	Development of PHER-O2, a blood substitute
Synthetic Blood International, Inc.	N/A	Costa Mesa, CA	6	$0.5	www.sybd.com	Biomedical product development company specializing in liquid ventilation, oxygen therapeutics, blood substitutes, and implanted glucose sensing
University of British Columbia, Center for Blood Research	N/A	Vancouver, Canada	31	N/A	www.cbr.ubc.ca	University research facility dedicated to applying biotechnology to the study of blood and blood processing
Pharmaceuticals: Genetically Engineered Inoculation						
Bharat Biotech International, Ltd.	1996	Hyderabad, India	N/A	N/A	www.bharatbiotech.com	Research, development, and manufacture of vaccines, bio-therapeutics, and biopharmaceuticals
Diosynth Biotechnology	1923	Morrisville, NC	3,000	$612.5	www.diosynthbiotechnology.com	Manufacture protein biopharmaceuticals
GlaxoSmithKline	2000	London, U.K.	100,919	$38,238.0	www.gsk.com	Develop and manufacture pharmaceuticals
Medical University of Vienna	N/A	Vienna, Austria	N/A	N/A	www.meduniwein.ac.at	Major University
Therion Biologics Corporation	1991	Cambridge, MA	75	$5.0	www.therionbio.com	Therapeutic vaccines for cancer patients
U.S. Army Medical Research Institute of Infectious Diseases (USAMRIID)	1969	Frederick, MD	750	N/A	www.usamriid.army.mil	Basic and applied research on biological threats resulting in medical solutions to protect military service members
Propulsion: Dual-Pulse Third-Stage Rocket Motor for Interceptor						
Alliant Techsystems (ATK)	1990	Edina, MN	13,100	$2,366.2	www.atk.com	Propulsion, ordinance, and control systems and ammunition systems
Propulsion: Dual-Pulse Third-Stage Rocket Motor for Interceptor – Ceramic Rocket Nozzle						
Ceramight, Ltd.	2002	Yavne, Israel	90	$12.6	www.tritonsys.com	Advanced composite material research and development for high temperature engine applications
Lockheed Martin Space Systems	N/A	Sunnyvale, CA	6,000	$647.3	www.lockheedmartin.com	Production and integration of launch vehicles and systems
Plasma Processes Inc.	1993	Huntsville, AL	23	$2.8	www.plasmapros.com	Rocket engine components, high temperature materials, and complete surface coating solutions
Triton Systems, Inc.	1992	Chelsford, MA	90	$12.6	www.tritonsys.com	Contract research and development, specifically advanced materials and high-temperature engine applications

[1] **Companies listed are representative; the list is not exhaustive. Inclusion or exclusion does not imply future business opportunities with or endorsement by DoD.**

Sources: SEC Filings, Orbis Bureau van Dijk databases, RDS Business and Industry database, LexisNexis Academic Universe, S&P reports, Hoover's, US Major Companies Database, Yahoo Finance, US Business Directory, Dun & Bradstreet, and First Equity research.

Technology Suppliers [1]						
Company Name	**Est.**	**Location**	**Employees**	**Sales (US$M)**	**Website**	**Technology / Line of Business**
Propulsion: Rapid Acceleration Booster for Boost/Mid Course Interceptor						
Almaz - Antey Corporation	N/A	Moscow, Russia	N/A	N/A	N/A	Former Soviet Union defense company and developer of the S-300V missile system
Israeli Aircraft Industries	1953	Tel Aviv, Israel	14,500	$2,062.0	www.iai.co.il	Components, parts, and systems for military and commercial aerospace
Lockheed Martin	1994	Bethesda, MD	130,000	$31,824.0	www.lockheedmartin.com	Design, manufacture, and integrate advanced technology products
Orbital Sciences Corporation	1982	Dulles, VA	2,160	$581.5	www.orbital.com	Small space and rocket systems
Pratt & Whitney Space Propulsion	2000	San Jose, CA	4	$0.3	www.pratt-whitney.com	Advanced propulsion solutions for space launch vehicles and missiles
Propulsion: Rapid Acceleration Booster for Boost/Mid Course Interceptor – Solid Fuel Rocket Motor Vectorable Nozzle						
Aerojet	1944	Sacramento, CA	2,700	$1,192.0	www.aerojet.com	Missile and space propulsion, and defense and armaments
Alliant Techsystems (ATK)	1990	Edina, MN	13,100	$2,366.2	www.atk.com	Propulsion, ordinance, and control systems and ammunition systems
Almaz - Antey Corporation	N/A	Moscow, Russia	N/A	N/A	N/A	Former Soviet Union defense company and developer of the S-300V missile system
China Chang Feng Mechanics and Electronics Technology Academy (CCF)	1957	Beijing, China	7,000	N/A	www.bcf.com.cn	Design of aerospace vehicles and large-scale system engineering
Pratt & Whitney Space Propulsion	2000	San Jose, CA	4	$0.3	www.pratt-whitney.com	Advanced propulsion solutions for space launch vehicles and missiles
Snecma Propulsion Solide	N/A	Paris, France	1,354	$241.1	www.snecma.com	Design and production of solid rocket motors and advanced thermo-structural composites
Robotics: Crawling UUVs						
Carnegie Mellon University	1900	Pittsburgh, PA	3,000	N/A	www.cmu.edu	Major University
City University of Hong Kong	1984	Hong Kong, China	400	N/A	www.cityu.edu.hk	Major University
Fraunhofer AIS	1949	Sankt Augustin, Germany	8,725	$705.5	www.ais.fraunhofer.de	Contract research and development
iRobot	1992	Burlington, MA	120	$13.5	www.irobot.com	Design and manufacture robots
Northeastern University Marine Sciences Center	N/A	Nahant, MA	N/A	N/A	www.neurotechnology.neu.edu	Develop biomimetic autonomous underwater vehicles
Signature Reduction: Active Magnetic Signature Reduction System						
Davis Engineering, Ltd.	1975	Ottawa, Canada	50	N/A	www.davis-eng.com	Technical R&D and consulting
EMS Development Corporation	1972	Yaphank, NY	40	N/A	www.emsdevelopment.com	Manufacture magnetic silencing/degaussing equipment and custom magnetics
Foster Miller, Inc.	1956	Waltham, MA	300	$89.9	www.foster-miller.com	Commercial product and equipment engineering and development
Polyamp	1966	Atvidaberg, Sweden	43	$4.9	www.polyamp.com	Design and manufacture control systems for naval mine countermeasure applications
Signature Management Systems	N/A	Cannock, U.K.	N/A	N/A	www.pmes.com	Underwater fixed and portable signature measurement range systems, onboard systems and magnetic and electric sensors

[1] **Companies listed are representative; the list is not exhaustive. Inclusion or exclusion does not imply future business opportunities with or endorsement by DoD.**

Sources: SEC Filings, Orbis Bureau van Dijk databases, RDS Business and Industry database, LexisNexis Academic Universe, S&P reports, Hoover's, US Major Companies Database, Yahoo Finance, US Business Directory, Dun & Bradstreet, and First Equity research.

Technology Suppliers [1]						
Company Name	**Est.**	**Location**	**Employees**	**Sales (US$M)**	**Website**	**Technology / Line of Business**
Structures: Composite Radar Absorbing Materials						
BAE Systems	1977	Bristol, United Kingdom	68,400	$14,911.2	www.baesystems.com	Designs, manufactures, and supports military aircraft, surface ships, submarines, space systems, radar, avionics, C4ISR, electronic systems
Cuming Microwave Corporation	1980	Avon, MA	76	$4.5	www.cumingmw.com	Manufacture microwave components and RF electromagnetic products
Hollingsworth & Vose Company	1843	East Walpole, MA	N/A	N/A	www.hollingsworth-vose.com	Manufacture technical, filter, and specialty papers, nonwovens, and advanced composites
Laboratory of Advanced Technology for Materials Synthesis and Processing, Wuhan University of	1893	Wuhan, China	5,000	N/A	www.whu.edu.cn	Major University
Laird Technologies	1864	Delaware Water Gap, PA	N/A	N/A	www.lairdtech.com	Manufacture electromagnetic interference (EMI) shielding materials
Umoe Mandal	1989	Mandal, Norway	N/A	N/A	www.mandal.umoe.no	Naval yard for ships built in FRP composites
Structures: Low-Observable Hullform						
BAE Systems	1977	Bristol, United Kingdom	68,400	$14,911.2	www.baesystems.com	Designs, manufactures, and supports military aircraft, surface ships, submarines, space systems, radar, avionics, C4ISR, electronic systems
Bath Iron Works	1884	Bath, ME	6,500	$497.8	www.gdbiw.com	Naval shipyard utilizing advanced composites
Direction des Constructions Navales	1926	Paris, France	12,700	$1,213.8	www.dcn.fr	Naval prime contractor, shipbuilder and systems integrator
Kockums AB	1873	Malmo, Sweden		$1,200.0	www.kockums.se	Design and build submarines and naval surface vessels that incorporate stealth technology
Lockheed Martin - Maritime Systems & Sensors	N/A	Moorestown, NJ	11,000	N/A	www.lockheedmartin.com	Systems integration of network-centric naval combat systems
Northrop Grumman	2000	Los Angeles, CA	122,600	$26,206.0	www.northropgrumman.com	Defense prime contractor and systems integrator
Structures: Low-Observable Hullform – Low-Observable Antennas						
Ball Aerospace & Technologies Corp.	1995	Boulder, CO	2,750	$491.0	www.ball.com	Design and manufacture imaging, communications, and information systems for aerospace
Direction des Constructions Navales	1926	Paris, France	12,700	$1,213.8	www.dcn.fr	Naval prime contractor, shipbuilder and systems integrator
Ericsson Microwave Systems	1956	Gothenburg, Sweden	2,000	$9.7	www.ericsson.com	Defense electronics and military information networks
Harris Corporation	1926	Melbourne, FL	10,900	$2,518.6	www.harris.com	Microwave, satellite, and other wireless network transmission equipment; air traffic control systems; mobile radio systems; and digital network broadcasting and management systems
Northrop Grumman	2000	Los Angeles, CA	122,600	$26,206.0	www.northropgrumman.com	Defense prime contractor and systems integrator
Roke Manor Research	1956	Romsey, U.K.	431	$50.0	www.roke.co.uk	Contract R&D for communications and electronic sensors businesses
Structures: Low-Observable Hullform – Thermo-Insulating Paint						
Colebrand International, Ltd.	N/A	London, U.K.	N/A	N/A	www.colebrand.com	Stealth and protective materials for aircraft, ships, submarines and land vehicles
Degaussa Building Systems	N/A	Shakeopee, MN	N/A	N/A	www.degaussa.com	Manufacture building and construction materials
Surface Optics Corporation	1978	San Diego, CA	39	$4.6	www.surfaceoptics.com	Manufacture electrical measuring instruments

[1] Companies listed are representative; the list is not exhaustive. Inclusion or exclusion does not imply future business opportunities with or endorsement by DoD.

Sources: SEC Filings, Orbis Bureau van Dijk databases, RDS Business and Industry database, LexisNexis Academic Universe, S&P reports, Hoover's, US Major Companies Database, Yahoo Finance, US Business Directory, Dun & Bradstreet, and First Equity research.

Technology Suppliers [1]						
Company Name	**Est.**	**Location**	**Employees**	**Sales (US$M)**	**Website**	**Technology / Line of Business**
Structures: Composite Radar Absorbing Materials						
BAE Systems	1977	Bristol, United Kingdom	68,400	$14,911.2	www.baesystems.com	Designs, manufactures, and supports military aircraft, surface ships, submarines, space systems, radar, avionics, C4ISR, electronic systems
Cuming Microwave Corporation	1980	Avon, MA	76	$4.5	www.cumingmw.com	Manufacture microwave components and RF electromagnetic products
Hollingsworth & Vose Company	1843	East Walpole, MA	N/A	N/A	www.hollingsworth-vose.com	Manufacture technical, filter, and specialty papers, nonwovens, and advanced composites
Laboratory of Advanced Technology for Materials Synthesis and Processing, Wuhan University of	1893	Wuhan, China	5,000	N/A	www.whu.edu.cn	Major University
Laird Technologies	1864	Delaware Water Gap, PA	N/A	N/A	www.lairdtech.com	Manufacture electromagnetic interference (EMI) shielding materials
Umoe Mandal	1989	Mandal, Norway	N/A	N/A	www.mandal.umoe.no	Naval yard for ships built in FRP composites
Structures: Low-Observable Hullform						
BAE Systems	1977	Bristol, United Kingdom	68,400	$14,911.2	www.baesystems.com	Designs, manufactures, and supports military aircraft, surface ships, submarines, space systems, radar, avionics, C4ISR, electronic systems
Bath Iron Works	1884	Bath, ME	6,500	$497.8	www.gdbiw.com	Naval shipyard utilizing advanced composites
Direction des Constructions Navales	1926	Paris, France	12,700	$1,213.8	www.dcn.fr	Naval prime contractor, shipbuilder and systems integrator
Kockums AB	1873	Malmo, Sweden		$1,200.0	www.kockums.se	Design and build submarines and naval surface vessels that incorporate stealth technology
Lockheed Martin - Maritime Systems & Sensors	N/A	Moorestown, NJ	11,000	N/A	www.lockheedmartin.com	Systems integration of network-centric naval combat systems
Northrop Grumman	2000	Los Angeles, CA	122,600	$26,206.0	www.northropgrumman.com	Defense prime contractor and systems integrator
Structures: Low-Observable Hullform – Low-Observable Antennas						
Ball Aerospace & Technologies Corp.	1995	Boulder, CO	2,750	$491.0	www.ball.com	Design and manufacture imaging, communications, and information systems for aerospace
Direction des Constructions Navales	1926	Paris, France	12,700	$1,213.8	www.dcn.fr	Naval prime contractor, shipbuilder and systems integrator
Ericsson Microwave Systems	1956	Gothenburg, Sweden	2,000	$9.7	www.ericsson.com	Defense electronics and military information networks
Harris Corporation	1926	Melbourne, FL	10,900	$2,518.6	www.harris.com	Microwave, satellite, and other wireless network transmission equipment; air traffic control systems; mobile radio systems; and digital network broadcasting and management systems
Northrop Grumman	2000	Los Angeles, CA	122,600	$26,206.0	www.northropgrumman.com	Defense prime contractor and systems integrator
Roke Manor Research	1956	Romsey, U.K.	431	$50.0	www.roke.co.uk	Contract R&D for communications and electronic sensors businesses
Structures: Low-Observable Hullform – Thermo-Insulating Paint						
Colebrand International, Ltd.	N/A	London, U.K.	N/A	N/A	www.colebrand.com	Stealth and protective materials for aircraft, ships, submarines and land vehicles
Degaussa Building Systems	N/A	Shakeopee, MN	N/A	N/A	www.degaussa.com	Manufacture building and construction materials
Surface Optics Corporation	1978	San Diego, CA	39	$4.6	www.surfaceoptics.com	Manufacture electrical measuring instruments

[1] **Companies listed are representative; the list is not exhaustive. Inclusion or exclusion does not imply future business opportunities with or endorsement by DoD.**

Sources: SEC Filings, Orbis Bureau van Dijk databases, RDS Business and Industry database, LexisNexis Academic Universe, S&P reports, Hoover's, US Major Companies Database, Yahoo Finance, US Business Directory, Dun & Bradstreet, and First Equity research.

Technology Suppliers [1]						
Company Name	**Est.**	**Location**	**Employees**	**Sales (US$M)**	**Website**	**Technology / Line of Business**
Structures: Miniaturized Satellites/Nano-satellites						
AeroAstro, Inc	1988	Ashburn, VA	50	$4.9	www.aeroastro.com	Microsatellite and nanosatellite systems, components, and technology
Orbital Sciences Corporation	1982	Dulles, VA	2,160	$581.5	www.orbital.com	Small space and rocket systems
SpaceDev, Inc.	1997	Poway, CA	30	$3.0	www.spacedev.com	Microsatellites and subsystems
Surrey Satellite Technology,	1985	Surrey, U.K.	146	$27.3	www.sstl.co.uk	Small satellite engineering research
Tsinghua University and Aerospace Tsinghua Satellite Technology Co	N/A	Tsinghua, China	N/A	N/A	www.htsl.com.cn	Major University
University of Toronto Institute for Aerospace Studies	1949	Toronto, Canada	N/A	N/A	www.utias.utoronto.ca	Graduate studies and research institute
Structures: Miniaturized Satellites/Nano-satellites – Nano-satellite Bus						
AeroAstro, Inc	1988	Ashburn, VA	50	$4.9	www.aeroastro.com	Microsatellite and nanosatellite systems, components, and technology
De Leon Technologies, LLC	N/A	Cape Canaveral, FL	3	$0.2	www.deleontechnologies.com	Aerospace life support systems
Precision Instrument Development Center	1974	Hsinchu, Taiwan	N/A	N/A	www.pidc.gov.tw	Governmental research center aiming to develop specific technology and manufacturing capabilities for precision instrument
SpaceDev, Inc.	1997	Poway, CA	30	$3.0	www.spacedev.com	Microsatellites and subsystems
Surrey Satellite Technology,	1985	Surrey, U.K.	146	$27.3	www.sstl.co.uk	Small satellite engineering research
Tsinghua University and Aerospace Tsinghua Satellite Technology Co	N/A	Tsinghua, China	N/A	N/A	www.htsl.com.cn	Major University
Structures: Miniaturized Satellites/Nano-satellites – Miniaturized Star-tracker						
AeroAstro, Inc	1988	Ashburn, VA	50	$4.9	www.aeroastro.com	Microsatellite and nanosatellite systems, components, and technology
Air Force Research Laboratory (AFRL), Directed Energy Directorate	N/A	Kirtland Air Force Base, NM	600	$130.0	www.de.afrl.af.mil	Develop, integrate, and transition science and technology for directed energy including high power microwaves, lasers, adaptive optics, imaging, and effects
Goodrich	1870	Charlotte, NC	22,900	$4,382.9	www.goodrich.com	Manufacture aircraft parts and components
Surrey Satellite Technology,	1985	Surrey, U.K.	146	$27.3	www.sstl.co.uk	Small satellite engineering research
Technical University of Denmark	2001	Kgs. Lyngby, Denmark	200	N/A	www.oersted.dtu.dk	Teaching and research in development and implementation of electrical systems

[1] **Companies listed are representative; the list is not exhaustive. Inclusion or exclusion does not imply future business opportunities with or endorsement by DoD.**

Sources: SEC Filings, Orbis Bureau van Dijk databases, RDS Business and Industry database, LexisNexis Academic Universe, S&P reports, Hoover's, US Major Companies Database, Yahoo Finance, US Business Directory, Dun & Bradstreet, and First Equity research.

Technology Suppliers [1]						
Company Name	**Est.**	**Location**	**Employees**	**Sales (US$M)**	**Website**	**Technology / Line of Business**
Structures: Miniaturized Satellites/Nano-satellites – Miniaturized Sun Sensor						
AeroAstro, Inc	1988	Ashburn, VA	50	$4.9	www.aeroastro.com	Microsatellite and nanosatellite systems, components, and technology
Optical Energy Technologies, Inc. (OET)	1984	Stamford, CT	5	$0.0	www.opticalenergy.com	Electro-optical, electronic, mechanical, and instrument system design
Sigma Space Corporation	1998	Lanham, MD	42	$4.8	www.sigmaspace.com	Instrumentation development and engineering services for the aerospace industry
Surrey Satellite Technology,	1985	Surrey, U.K.	146	$27.3	www.sstl.co.uk	Small satellite engineering research
Technical University of Denmark	2001	Kgs. Lyngby, Denmark	200	N/A	www.oersted.dtu.dk	Teaching and research in development and implementation of electrical systems
University of Naples	1224	Naples, Italy	N/A	N/A	www.unina.it	Major University
Textiles: Multi-Spectral Camouflage Cover						
Colebrand International, Ltd.	N/A	London, U.K.	N/A	N/A	www.colebrand.com	Stealth and protective materials for aircraft, ships, submarines and land vehicles
Millimeter Wave Technology	1983	Passaic, NJ	12	$0.9	www.mwt-materials.com	Research, development, and manufacture of radar absorbing materials and coatings
Radian, Inc.	1977	Alexandria, VA	300	$56.0	www.radianinc.com	Engineering, logistics, system integration, and life-cycle management services
Saab AB	1937	Linkoping, Sweden	13,316	$2,380.5	www.saab.se	Develop and manufacture advanced products and services for the defense market
Texplorer GmbH	1998	Nettetal, Germany	N/A	N/A	www.texplorer.de	Design, develop, and produce high tech military textiles
Textiles: Ultra-Lightweight Protective Suit						
Blucher, GmbH	1965	Erkath, Germany	48	$46.9	www.blucher.com	Manufacture stainless-steel drainage systems
Creative Apparel Associates	1989	Belfast, ME	280	$18.0	www.creativeaa.com	Manufacture military chemical protective garments
Innovative Chemical and Environmental Technologies (ICET), Inc.	N/A	Norwood, MA	8	N/A	www.icetinc.com	Electrochemistry, catalysis, and surface modification of polymers and inorganic materials research and development
Physical Sciences, Inc.	1973	Andover, MA	150	$29.2	www.psicorp.com	Contract research and development
Taiwan Carbon Technology Co.	1996	Taichung, Taiwan	15	$0.4	www.taicarbon.com.tw	Manufacture, supply and development of activated carbon fiber
Texplorer GmbH	1998	Nettetal, Germany	N/A	N/A	www.texplorer.de	Design, develop, and produce high tech military textiles
Tex-Shield, Inc.	N/A	Washington, DC	45	$1.6	www.nbcindustrygroup.com/tex.htm	Manufacture and distribute chemical protective clothing and textile products

[1] **Companies listed are representative; the list is not exhaustive. Inclusion or exclusion does not imply future business opportunities with or endorsement by DoD.**

Sources: SEC Filings, Orbis Bureau van Dijk databases, RDS Business and Industry database, LexisNexis Academic Universe, S&P reports, Hoover's, US Major Companies Database, Yahoo Finance, US Business Directory, Dun & Bradstreet, and First Equity research.

APPENDIX D

POLICY PORTALS AND LEVERS

(This page intentionally left blank.)

MAJOR INNOVATION PORTALS AND POLICY LEVERS IN THE INDUSTRIAL PROCESS[1]

ODUSD(IP) has developed a policy construct to incentivize innovation in industrial base capabilities and to remedy deficiencies. This policy construct promotes a systematic approach to address industrial base development and avoid deficiencies.

Maintaining the U.S. warfighting advantage requires continuous innovation of critical warfighting capabilities. Key among many factors driving innovation is competition among ideas and the application of those ideas. Ideally, the Department would like more competition for the most critical warfighting capabilities, those facilitating asymmetric advantages. Ideally, as well, the Department would seek to lower risks by choosing and developing domestic suppliers to provide those technologies where the United States wants to have warfighting capabilities superior to those of potential adversaries. Clearly, however, we would not deprive the warfighter when a foreign source has the best solution. By the same token, the Department also seeks to ensure that key technology is protected through export controls and other interagency measures. However, as the criticality of the warfighting capability lessens, the need for competitive U.S. sources to drive innovation of that capability also lessens.

Portals and Levers for Policy Implementation

Management of critical industrial capabilities requires policy implementations. There are three major policy levers that can be used to remedy instances in which required industrial capabilities are insufficient: (1) fund innovation; (2) optimize program management structures and acquisition strategies; and (3) apply external corrective measures where warranted.

These levers are best employed through the five openings or portals into the acquisition process where we believe the most effective influence on the industrial base can be achieved. These key opportunities to innovate the industrial base are: (1) science and technology (S&T); (2) the transition from laboratory to manufacturing; (3) weapon system design; (4) make/buy decisions; and (5) life cycle innovation.

The Department's challenge is to identify, monitor, and act to ensure that the critical technologies and industrial capabilities required to develop and field warfighting capabilities are sufficient in number and have the level of innovation necessary to meet projected DoD requirements. In addition, our assessment that technologies were critical enough to assess on a priority basis was based on the

[1] Excerpt taken from *DIBCS BA*, Part III, published January 2004. Therefore, illustrative examples given in this Appendix are primarily BA resources.

multiple application of these technologies. As a consequence, these recommended actions might also foster applying critical technologies across multi-Service joint applications. By highlighting industrial base deficiencies for critical technologies and implementing appropriate policy initiatives and remedies, the Department will continue to foster the innovative industrial base that is the basis of our warfighting advantage.

How Portals and Levers Work

Our analysis led us to focus on the five primary portals through which the Department can assure sufficiency of sources and innovation—and potentially also tap into particularly innovative technology to pollinate it among other applications. Acquisition policy guidance encourages Department acquisition professionals to appropriately deploy policy levers through these portals as a normal practice throughout the industrial processes that define a program. However, such guidance sometimes is overcome by other programmatic priorities. Particularly in cases where required industrial capabilities are insufficient or have cross-platform utility, remedial action may help optimize outcomes.

Early in responding to an emerging warfighting requirement, critical industrial capabilities may be resident in too few potential suppliers to generate confidence in timely success. For example, when developing or applying a new technology or developing a missing key system or systems enabler, sources may be limited to the incumbent suppliers of the previous generation of that technology, such as in the development of Global Hawk, which is discussed later in this Appendix. The available sources may also not be able to address multiple applications of a given technology. The Department should be prepared to act in such situations.

Later, in concept development or weapon system development and design, the number of potential suppliers may be insufficient to generate innovation or price competition due to industry consolidation, teaming arrangements, waning interest, or other factors. The Navy's Future Destroyer (DDX) program is a good example of an instance in which the Department acted in such a situation to ensure the availability of an innovative, competitive industrial base.

For mature systems or in mature industries, contractors may choose to source commonly available components from the global industrial base for reasons of best performance and cost. Additionally, older systems may be so far removed from the state-of-the-art that domestic suppliers deliberately discontinue producing necessary subsystems and components. While the Department is less concerned as a whole about such situations, it should act in the make-buy decisions and throughout programs' life cycles to induce innovation as much as possible.

In our construct, management decisions and options can be examined systematically using the array of portals and levers, as discussed in this Appendix. Portals generally correspond to program phases. In the case of applying remedies, the phase of the program determines which portals apply. The *science and technology* portal should be open nearly continuously for the more critical technologies since we should evolve these technologies until they reach their scientific limitations. Optimally, the *make/buy decisions* and the *life cycle innovation* portals are also open nearly continuously once a system is fielded so that technology refresh can be accomplished as necessary. The *transition from lab to manufacturing* and the *weapon systems design* portals represent more limited windows of opportunity. In this construct as illustrated below, once the portal(s) have been determined, the three levers (*fund innovation*, *optimize program management/acquisition strategy*, and *employ external measures*) are systematically considered for how to best influence the desired outcome. The remedy or remedies can then be mapped on the board. This is the construct we will discuss further in the pages that follow: first portals and then levers.

MAJOR INNOVATION PORTALS AND POLICY LEVERS IN THE INDUSTRIAL PROCESS

Portals / Levers	Science & Technology	Lab to Manufacturing	Weapon System Design	Make/Buy Decisions	Life Cycle Innovation
Fund Innovation					
Optimize Program Management/ Acquisition Strategy					
Employ External Measures					

Source: ODUSD (IP)

To illustrate the portals and levers, we use a number of examples. These examples include opportunities taken to use a lever effectively and opportunities lost. While the examples come from a variety of programs, the discussion here is focused on industrial base impacts of the action taken or not taken and are not intended to reflect on the overall status or outcome of the program.

INNOVATION PORTALS

This study's focus on innovation is driven by the need to *Be Ahead* or Be *Way Ahead* in critical technologies. As depicted in the graphic on the previous page, there are five major portals of opportunity where managerial decisions determine the likelihood that critical technologies and associated industrial capabilities are developed and sustained expeditiously and cost-effectively:

- *Science & Technology*. Programmatic and funding decisions by both the government and industry involving technology development significantly impact the likelihood that there will be sufficient industrial capabilities to incorporate critical technologies in defense systems. A capabilities-based approach like the DIBCS methodology can serve as a guide for shaping these decisions by stimulating investment in critical industrial base capabilities.

- *Laboratory to Manufacturing Transition*. Manufacturing approaches that optimize either for manufacture by the developer or for only one warfighting application often transition new technologies from the laboratory to production with unintended limitations. For critical enabling technologies like those identified earlier, the Department should encourage manufacturing processes that encourage competitive solutions and enable their transition to other applications. Industrial base concerns must, of course, be balanced against delays that preclude the timely delivery of new operational capabilities to the warfighter.

- *Weapon System Design*. Design practices (for example, the effective use of standard software and hardware interfaces) can encourage innovation. On the other hand, government or prime contractor specifications that are too prescriptive can undermine innovation. This often is the case in subsystems or components that optimize designs around single-supplier products, applications, or technologies. This kind of behavior leads to sub-optimized designs and sole sources. The Department's policy on the use of an open systems approach promotes the use of products from multiple suppliers and allows next generation modules to be inserted to upgrade capabilities throughout the life cycle of the weapon system. A key attribute of evolutionary acquisition and spiral development is planning and managing technology insertion to foster opportunities for new warfighting applications from original—and new—manufacturing sources.

- *Make/Buy Decisions*. Contractor make or buy decisions are the front lines of competition and innovation. For critical technologies, the policy levers should be used within this portal to encourage contractors not to favor in-house capabilities or long-term teammate products over more innovative solutions available elsewhere. When warranted, the

Department will engage actively to shape make/buy decisions. This is not a new policy but requires advanced planning in the acquisition strategy.[2] Unwarranted favoritism, especially if systemic, discourages innovative suppliers. Warfighters lose when contractors try to satisfy critical capability requirements without choosing the most innovative, best-value suppliers.

- *Life Cycle Innovation*. Under evolutionary acquisition strategies, even more so than in the past, fielded defense systems will continue to undergo further development to improve warfighting capabilities. These innovative improvements offer new opportunities to import emerging technological and industrial capabilities that maintain or expand warfighting superiority. Thus, they should draw from the broadest possible spectrum of the overall industrial base. As a consequence, cost-effective commercial practices and standards and open architectures become particularly important.

Traditionally, these portals have been the provinces of a discrete set of industrial base participants aligned to specific phases within the industrial process as shown below.

TRADITIONAL INNOVATION PORTALS AND INDUSTRIAL PROCESS PARTICIPANTS

Program Phases	Science & Technology	Lab to Manufacturing	Weapon System Design	Make/Buy Decisions	Life Cycle Innovation
Participants	Inventors, Academia, Government Labs and R&D Centers, Domestic And Foreign Industry	Service Labs, Program Offices, Industry, Commercial and Government Centers of Excellence (e.g., NCMS, Fraunhofer Institute)	Industry/ Government Program Office	Industry	Industry/ Government Program Office

Source: ODUSD (IP)

For example, inventors, academia, laboratories, government and industry research and development centers, and industry generally all act in the *science and technology* portal. However, as programs proceed through *weapon system design*, *make/buy decisions*, and *life cycle innovation* portals, the breadth of participants generally narrows to include only industry and government program personnel. This practice is akin to premature down-selection, foreclosing access to the broader defense industrial base and reducing innovation potential. Our

[2] Government involvement in make/buy decisions is illustrated in explicit subsystem acquisition strategies like the E-10A (see page D-16), Space Based Radar (see page D-16), as well as the consent decrees associated with the Northrop-Grumman/TRW case (see page D-22). Less extreme measures such as make/buy plans and award fee criteria can be applied routinely.

first example of the *life cycle innovation* portal (and *acquisition strategy* lever) also is an example of broad industrial base participation to solve a critical need.

ARCI EXAMPLE

- Rapid insertion of technology to enhance system performance, including commercial technology
- Use of maximum breadth of industrial base provides for frequent competitions
- Annual portal for technology refresh and innovation prevents Navy from being captive to a single contractor

The Navy applied the *acquisition strategy* lever to induce innovation and competition in submarines as part of *life cycle innovation* in response to advances in world submarine acoustic technology in the mid-1990s. In 1996, the Navy adopted a revolutionary plan to maintain superiority by applying state-of-the-art signal processing in state-of-the-practice COTS hardware and software. The Acoustic Rapid Commercial off-the-shelf (COTS) Insertion (ARCI) program restored the Navy's submarine acoustic superiority and provided an innovative approach to continued improvement.

In ARCI, the Navy uses standard hardware and software interfaces, and a capabilities-based (versus requirements-based) model to integrate skills from the Navy, academia, and small and large businesses. It developed a rigorous process which rapidly inserts advanced capability into the fleet on a regular basis. By partitioning the sonar system into processing strings, the Navy was able to leverage the strengths of the developers and enable a sequential and incremental capability insertion plan. ARCI prime contractor Lockheed Martin provides system integration and system management. Digital Systems Resources, now part of General Dynamics, developed the towed array. The Applied Research Laboratory at the University of Texas developed the high frequency active array; and John Hopkins University's Applied Physics Laboratory served as the advanced technology test program lead. Members of the advanced development community (Navy laboratories, academia, and industry) continue to provide the new ideas, algorithms, and implementations.

The use of standard hardware and software interfaces is fundamental to ARCI's ability to continue innovation throughout the system life cycle. Selecting standard interfaces commonly used throughout industry removes a significant barrier to supplier participation. Nearly any information technology supplier is familiar with internet protocols as well as common hardware architectures, operating systems, and application program interfaces. It is the adaptation of commonly used standards like these to defense requirements that enables participation by the broadest base of suppliers, including emerging defense suppliers. Standard hardware and software interfaces enable a maximum level of innovation for development and continued improvement of critical warfighter capabilities.

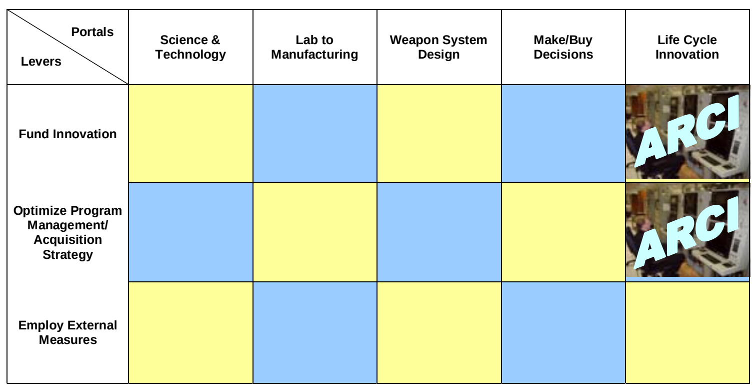
While the ARCI example focuses on the *life cycle innovation* portal, we believe that continuous use of these portals provide the best opportunities to influence the current and future sufficiency of the industrial base. Effective collaboration

among all industrial base participants through all program phases makes it possible to access and deploy the best available knowledge and ingenuity. It also makes more certain the Department's ability to identify and employ the appropriate policy levers discussed below to induce and sustain innovation across the breadth of the defense enterprise.

POLICY LEVERS

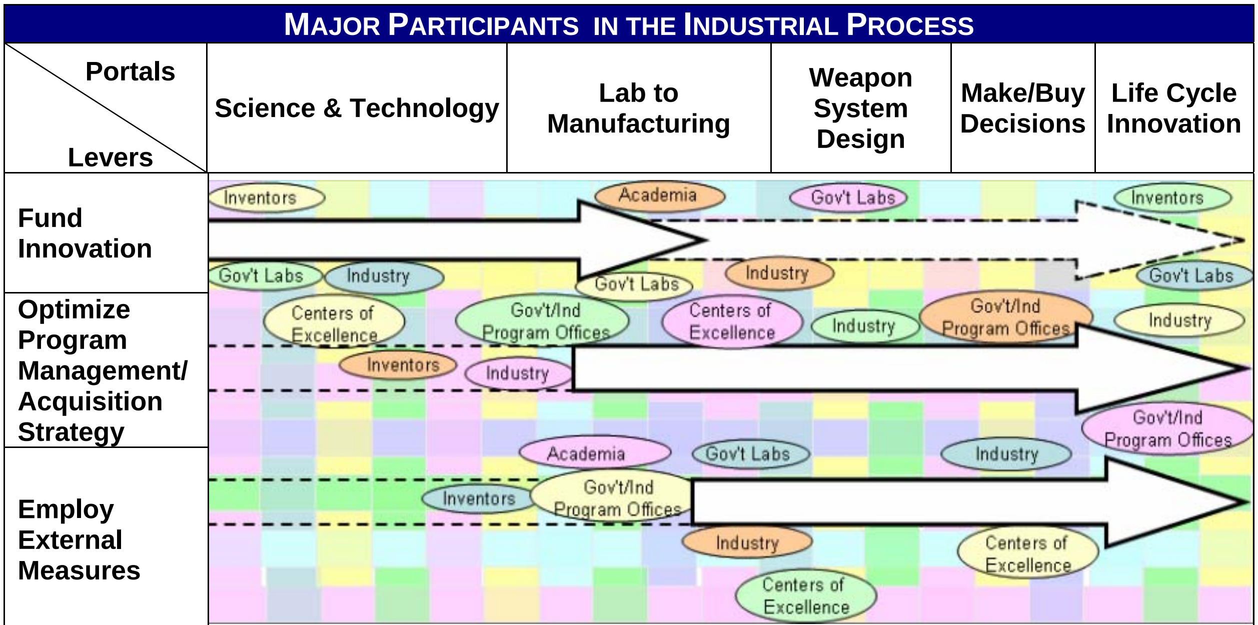
Three major policy levers offer tools with which the Department can develop, sustain, or expand innovation, drawing on the entirety of the industrial base, no matter the phase of the program. Ideally, DoD managers and contractors deploy these levers routinely through the appropriate portals discussed above to develop robust technological solutions to defense problems, insert those technologies, sustain critical industrial capabilities, and leverage those which may have applications elsewhere in the defense enterprise. For those cases where the Department determines that critical technological and industrial capabilities are deficient, it should carefully define the concern and use the appropriate lever to remedy the deficiency. For example, in the ARCI example just cited, the *life cycle innovation* portal was used with the *fund innovation* and *optimize acquisition strategy* levers, as shown in the graphic to the right.

PORTALS AND LEVERS APPLIED TO THE ARCI EXAMPLE



Source: ODUSD (IP)

The three levers we will now discuss are (1) *funding innovation*, (2) *optimizing program management and acquisition strategy*, and (3) *employing external measures* as necessary. Ideally, acquisition managers make use of all participants—laboratories, academia, industry, etc.—through all phases of a program's life cycle to nurture innovation in multiple sources for the purpose of acquiring leading-edge technologies at an affordable price, as shown in the graphic below. A discussion of each of the levers and associated examples follows.



Source: ODUSD (IP)

Fund Innovation

Direct funding of innovation by the government in its science and technology (S&T) accounts and by industry in independent research and development (IRAD) accounts is paramount. During government and industry laboratory development—and the transition from the laboratory to manufacturing and later—funding alternative technologies, as well as multiple applications and suppliers, broadens the industrial base. It also improves what is available to the warfighter, often at less cost.[3] Inadequate funding for innovation can have severe consequences—hence the significance of the Department's efforts to boost science and technology funding as a critical first step to develop multiple innovative sources and technology applications.

> *"Creating market conditions attractive to business will bring you all the capacity and innovation you can use."*
>
> *– Red Team Member*

The role of contracting officers, program managers, and other acquisition professionals in translating the intent of S&T funding to induce maximum innovation is critical. Too often, the intent to develop multi-application, joint capabilities from specific critical technologies is unintentionally undermined by

> *"Competitive early development is expensive and thus avoided, but sole source efforts often cost twice original estimate anyway. We lose technologically, and don't gain programmatically."*
>
> *– Red Team Member*

[3] In addition to classic S&T funding, other sources of innovation funding include the Defense Acquisition Challenge Program, Quick Reaction Fund, Defense Technology Transition Initiative, Advanced Concept Technology Demonstrations (ACTDs), Title III Program, Small Business Innovation Research programs, Small Business Technology Transfer programs, and Manufacturing Technology programs.

contracting actions made without strategic vision—or by programmatic decisions excessively focused on one program and its requirements. As evolutionary, broader, and more flexible acquisition tenets become increasingly important, it will be the challenge of the acquisition universities and other Department curricula to place more emphasis on the innovative paradigms so critical to 21st century warfighting. The functional area architects recommended in this study should also prove an asset to this process by constantly monitoring and comparing each other's portfolios of different capabilities and associated programs for maximum overall effectiveness. Examples that follow discuss use of the three major policy levers to source innovative technology applications.

UAV EXAMPLE

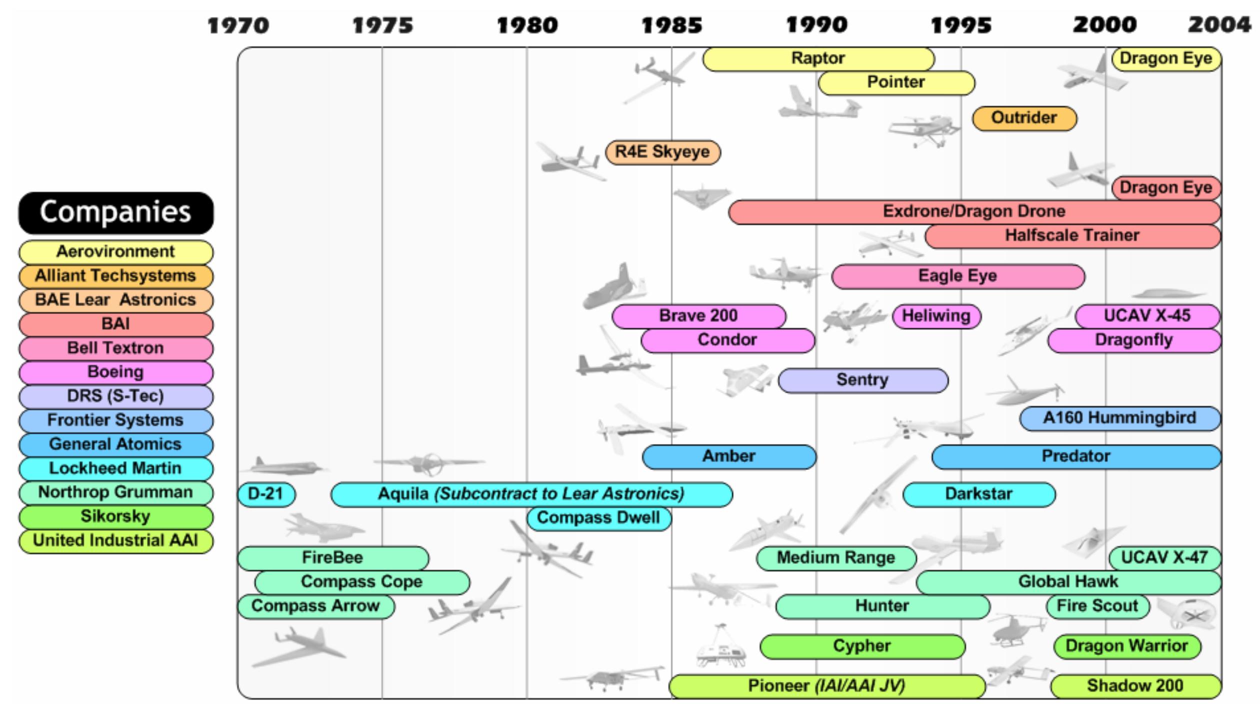
- Acquisition strategy created a single source
- Resulted in increased cost and schedule
- Represented a lost opportunity

The history of UAV development has not benefited from the hallmarks of successful aircraft development: ample funding and number of suppliers. Nor has the Department succeeded in fully migrating this extraordinary manned aircraft technology base to future unmanned applications. Consistent funding and multiple competitions enabled fighter aircraft, whose integrated sensor suites are key components of Battlespace Awareness, to become one of the most dominant warfighting capabilities of the U.S. forces from the period following World War II to the present. The United States now has a capability that assures such complete air dominance that potential adversaries generally don't dare challenge it. The Department achieved such dominance through consistent long-term funding for system innovation and through multiple competitions. In the first few decades after World War II, more than a dozen firms competed to develop and produce military aircraft. Subsequently, some firms left the business and others merged, resulting in eight remaining firms in 1990.[4] The Department nurtured innovation in military aircraft by engaging an ample number of suppliers in aircraft manufacturing over a period of more than 45 years.

Although UAVs are now almost universally identified as a critical technology, the history of their development has been marked by uneven funding due to lack of support by the Services, frequent program cancellations, and few competitions for large production contracts. As a result, no company has had the continuous activity that fosters evolutionary innovation—and the Department's progress in obtaining systems has been marked by fits and starts, impeding the development and diffusion of critical knowledge within the industrial base. The chart below illustrates the uneven nature of UAV development. Many companies over more than three decades have participated in this area—but none have had a long, continuous pattern of involvement in unmanned programs. In addition, many of these companies have exited or been subsumed in the process.

[4] Birkler, John, et. al. *Competition and Innovation in the U.S. Fixed-Wing Military Aircraft Industry*, Rand Corporation, 2003.

UAV DISJOINTED DEVELOPMENT PATTERN[5]



Source: Institute for Defense Analyses

The nature of UAV technology is such that a robust industrial base capability would be characterized as having innovative technologies with myriad applications; multiple suppliers because of low entry costs; and maximum use of COTS components or systems. The consequence of the Department's UAV procurement pattern is few deployed UAVs and a still-nascent capability in spite of the relatively long history of basic technology development. We can only guess where—and over how many applications—unmanned system innovation may have taken the Department had the history been different.

Consider, for example, the development of the Global Hawk UAV, now in high demand because of its demonstrated value in Operations Enduring Freedom and Iraqi Freedom. This is a case where the lever of funding innovation during weapon system design was intended to help maintain a competitive and innovative industrial capability. However, funding constraints led to a change in strategy and the opportunity was not realized. Global Hawk began as an Advanced Concept Technology Demonstration (ACTD) program leveraging Ryan's unmanned technology expertise going back several decades. It was selected in May 1995 from among five competing concepts. DARPA, the Global Hawk program manager, originally planned to fund two contractor teams through initial flight testing. However, budget cuts just prior to selection forced the Department to choose only a single contractor team.

---

[5] Affiliations in this chart reflect the companies as they exist today and not the heritage companies that may have initiated or contributed to the program.

If, on the other hand, the Department had funded multiple competing teams through initial flight test at a $160 million estimated cost for two, it would have significantly reduced: (1) performance risk because of competitive flight tests; (2) schedule risk arising from single source procurement; (3) super-optimization of one mission application and contractor approach; and (4) future acquisition costs by making available multiple sources for future competitions. This development program represented an early opportunity—not seized—to expand market demand and broaden the supplier base for a critical warfighting capability. The Department is now funding billions of dollars for UAV developments which could have blossomed earlier and at less cost—had the pressure to save $160 million not been so great in 1995.

Conversely, the Tactical Targeting Network Technology (TTNT) program demonstrates application of the *fund innovation* lever through the *weapon system design* portal to develop a robust and innovative supplier base. TTNT, also managed by DARPA, aims to provide the communications infrastructure to support tactical targeting from airborne platforms as part of the Joint Tactical Radio System. In early 2001, DARPA funded four large contractors to work on design requirements and four small contractors to focus on specific component technologies. In June 2002, DARPA chose one systems contractor and three small contractors to further mature TTNT technology and produce articles for testing—thereby continuing to fund multiple approaches. The Department ensured it retained ownership of TTNT intellectual property to facilitate the development of competition for subsequent phases of the program's life cycle.

TTNT EXAMPLE

- Acquisition strategy created innovative environment
- Source selection and management structure institutionalized this environment

From the beginning, the DARPA program manager funded a broader industrial base by soliciting industry responses for two sets of requirements: (1) total system requirements for which larger companies were better suited; and (2) component requirements that small companies with emerging technologies could best satisfy. DARPA funded an industrial base for this program of four system and four component suppliers in the preliminary design phase, reduced it to one system and three component suppliers a year later for the maturation of TTNT technology; and in the future production phase, will be able to attract more suppliers because of the Department's predominant ownership of the intellectual property, thereby allowing for expansion of the defense industrial base—if required.

Optimize Program Management and Acquisition Strategy

Over the years, the Department and its prime contractors have developed and employed a myriad of program management structures and acquisition strategies

primarily to optimize program cost, schedule, and performance—sometimes not considering the full impact of such structures and strategies on the industrial base. However, as the following examples illustrate, organizational structures and acquisition strategies can have a significant impact on the Department's ability to acquire multiple innovative sources to maintain technology leadership. Acquisition programs are at the front lines of shaping the defense industrial base. Tactics at the program-level must be consistent with the Department's strategies to develop sufficient industrial base capabilities, incentivize industry to be innovative, and to seek multi-application solutions.

> *"Robust competition to meet challenging performance goals is the most consistent source of innovation."*
>
> *- Red Team Member*

Government and industry program management structures, as well as acquisition strategies, can provide positive or negative impacts on the numbers of suppliers and sources of innovation. For example, government management structures can encourage the development of multiple suppliers. On the other hand, as discussed below, if they allow too narrow a focus on Service-specific applications with the prime contractor and its sub-contractors, they can work to discourage other contractors from contributing competing innovative technologies. Likewise, industry management structures can positively impact innovation. For example, partnering with competitors for contracts in specific program areas where there are few contract awards and limited funding can produce innovative synergies. In some instances, however, partnering can result in monopolistic behavior that works to exclude competitors and squelch innovation. Finally, acquisition strategies may impact innovation either positively or negatively. A strategy where the Department funds multiple sources in early technology development, for example, nourishes the growth of multiple, innovative sources. A strategy where contractors have too much responsibility for program development and inadequate government oversight may foster dependence on current suppliers to the exclusion of other sources of innovative solutions.

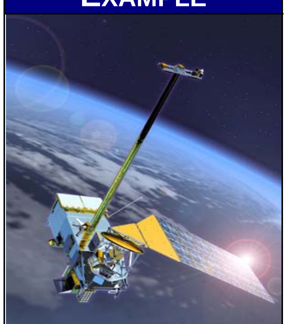
Traditional program cost, schedule and performance goals also can defeat program managers trying to apply strategies necessary to obtain the innovative technology the Department requires. The dynamic nature of program development and budget decisions can force changes in acquisition strategies to the detriment of broader industrial base considerations.

A case of program management structure masking industrial base problems is illustrated in Space-Based Infrared System-High (SBIRS-High). Here is a case where the *optimize program management structure and acquisition strategy* lever was not employed during weapon system design. The program office was structured to provide minimum management oversight of the contract using a total systems performance responsibility (TSPR) clause. Major problems of cost, schedule, and performance in SBIRS-High surfaced in late 2001 in part due to the inability of industry to produce key capabilities because of problems related to lack of maturity in the system design.[6] These problems forced both government and contractor program offices to be restructured. The Department's review of the program at that time identified government program office structural issues, government and contractor program management turnover, and the TSPR acquisition strategy collectively as major contributors to the program's problems. The recovery plan is attempting to correct these issues with a restructured contract and management team. This experience reminds the Department of the risks of inadequate program oversight. Lack of attention to the impact of management structure and acquisition strategy on program performance set the stage for program failure, and this program continues to struggle to recover.

SBIRS EXAMPLE

- Government program office structure proved to be inefficient in controlling cost, schedule and performance
- Required restructuring of government and contractor management teams
- Restructured contract to bring performance and technology into line

NPOESS EXAMPLE



- Program merger resulted in consolidation of competitive opportunities
- Acquisition strategy maintained robust competitive environment for innovative industrial capabilities

The combination of the military Defense Meteorological Support Program (DMSP) and the civil Polar-orbiting Operational Environmental Satellites (POES) saved significant money but risked reducing the opportunities for competition in a very innovative set of industrial capabilities. To address these risks, the integrated program office (IPO) for the National Polar-orbiting Operational Environmental Satellite System (NPOESS) addressed this impact to the industrial base through application of the *acquisition strategy* and *fund innovation* levers through the *weapon system design* portal. The merger did not change the number of satellites to be procured but did reduce the number of distinct satellite design opportunities from two to one. The resulting program was estimated to produce sizable cost savings of over $1.6 billion through 2018 by reducing redundancies in U.S. meteorological satellite systems. To avoid reducing the innovation in the industrial base along with the costs, the IPO employed acquisition strategies to

[6] Other causes cited during Nunn-McCurdy breach deliberations included lack of effective requirements and system engineering, and a breakdown in execution management within both Government and contractor teams.

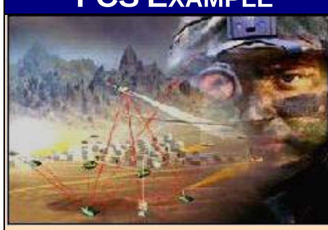
create a robust competitive environment by directing competitive subcontracts in the key sensor technologies. Losers of the sensor design competitions were allowed to team with the winners to leverage their best collaborative design and production capabilities, and stay engaged in one of the few major space-based remote sensing programs.

E-10A EXAMPLE

- Innovative management structure
- Competition-based acquisition strategy
- Results in an innovative industrial base for future competitions

Using the *management structure/acquisition strategy* lever to ensure multiple innovative sources will be even more challenging for future programs. As network-centric warfare demands synergies among defense systems, we are reminded that management structures and acquisition strategies must adapt to ensure the industrial base is properly incentivized to innovate key technologies—across multiple applications or missions. The E-10A Multi-Sensor Command and Control Aircraft program is an example of how the needs to replace several platforms can be met with a distinctive organization and acquisition strategy. The E-10A program employs a cluster of program offices within a lead program office, reinforcing common technologies and systems among the cluster's elements. The program's acquisition strategy is a hybrid as well. It has sole source system integration and platform contractors where the benefits of innovation and competition have already been garnered. However, where innovative technologies can provide critical capabilities, such as in the Battle Management Command and Control System, competition is preserved.

FCS EXAMPLE



- Innovative management structure has potential to generate competitive industrial base environment
- Lack of government oversight and over-reliance on industry as an LSI may have unintended negative consequences

The Future Combat System (FCS) offers an example of an innovative management structure and acquisition strategy approach designed for an extremely complex and massive network-centric program critical to the Department's 21st century warfighting needs. It is using the *management structures/acquisition strategy* lever through the *weapon system design* portal to gain access to system-of-systems and network-centric capabilities found in the larger prime contractors and system engineering houses while retaining full access to the rest of the industrial base to provide critical capabilities in the systems and components that make up FCS. The Army has selected a strategy that establishes a contractor lead system integrator (LSI)—the Boeing/SAIC team—that works closely with the government program office. SAIC and Boeing play a major role in establishing program standards and selecting component contractors. They manage the identification, selection, and procurement of the major FCS systems and subsystems, with the explicit challenge and mandate not to self-deal.

However, while it is too early to know for sure, the FCS LSI approach may not provide the government the necessary in-depth understanding of that program's impact on the industrial base, particularly for the application of innovative technologies developed in FCS for non-Army applications. Based on its experience with TSPR, the Department has expressed unease with such heavy reliance on a contractor team for key program decisions, especially faced with high Department program office turnover rates. Thus, it is critical that the Department maintain insight into the LSI contractor processes and procedures of this program to ensure that they satisfy industrial base outcomes. In FCS, the contract requirement that the Army Acquisition Executive review all decisions in the *make or buy* portal should help to mitigate this risk.

As these examples have illustrated, deploying the portals and levers in the construct we have developed differs for each situation. Developing a new technology or addressing an industrial base deficiency will require a solution crafted specifically for that deficiency. In making decisions, from resource allocation to acquisition strategies, the Department must ensure that the industrial base and strategies to ensure its sufficiency be considered—particularly in cases involving critical and multi-application technologies.

> *"The ability of acquisition managers to do this effectively depends on whether they continue to manage individual programs, which forces a parochial view, or a capability or technology area, which would cause them to optimize for that broader capability or technology area—a structural issue."*
>
> *– Red Team Member*

The future will demand great finesse in the application of the *program management/ acquisition strategy* lever if the Department is to synergize available industrial base capabilities across broad applications. It is for this reason that we recommend establishing the functional area architect and conducting industrial base assessments for critical capabilities throughout the program life cycle. With the functional architects in all acquisition board meetings to monitor acquisition strategies and elevate industrial base concerns, these reviews will become more effective in maximizing innovation to the benefit of warfighting capabilities—and the defense industrial base.

Changing warfare strategies must erode the familiar platform-centric patterns the Department has long used to structure its thinking, but will only do so in the measure that acquisition professionals view themselves as stewards of warfighting capabilities and not owners of stovepipe platforms. The rest of the Department is adapting to these changes in order to create acquisition processes that recognize the power of synergizing capabilities across Services and platforms. Even our historical platform-based milestone approval process is now undergoing revision to focus on gaps and overlaps in capabilities provided by systems, rather than on the discrete systems themselves. Acquisition strategies are already beginning to bear the imprint of the portals and levers construct to

challenge program managers to develop plans for innovation and innovative uses of their technologies—throughout program life cycles.

Employ External Measures

Previously we discussed two levers available to program managers to develop multiple sources of innovative technologies that can potentially be used to enhance multiple warfighting capabilities: *funding innovation* and *optimizing program management structures and acquisition strategies*. While these tools traditionally may be used to solve cost and technical quality problems, another important purpose is to ensure the development and sustainment of critical and innovative industrial base capabilities.

Now we will discuss measures external to the normal life cycle development of a program that the Department employs on an ongoing basis but also can employ when the first two levers do not secure sufficient innovation for critical capabilities. This third lever includes collaborating with other agencies to apply regulatory remedies in order to prevent undesired foreclosure of competition or innovation.

The graphic below depicts the seven "external" corrective measures available to the Department to remedy or prevent undesired effects on the industrial base. Three of them are external to individual programs, but internal to the Department. While the four on the right side of the chart are external to the Department, the Department has significant influence as to how these tools are employed.

EXTERNAL MEASURES			
DoD		**Interagency**	
Measure	**Purpose**	**Measure**	**Purpose**
Stage competitions to add sources	Induce innovation. Major risk reduction for too few/failing source(s) or lack of performance	Hart-Scott-Rodino Remedies	Maintain sufficient number of competitive sources
		Exon-Florio Remedies	Maintain technology leadership and security of supply but allow foreign direct investment
Restructure Management Approach	Eliminate excessive self-dealing or narrow focus on specific issues or applications	Balanced Export Controls	Keep military technology from adversaries but allow competition in global markets
Block Teaming Agreement	Discourage fusion of innovation into single source; prevent cartel-like behavior	Foreign Cooperative Agreements	Help develop and access foreign sources where appropriate
Source: ODUSD (IP)			

Funding permitting, the Department can stage competitions to add sources in order to induce innovation and improved performance, while reducing risk. When innovation is desired, competitions must avoid contract clauses and acquisition strategies that encourage risk-averse behavior and drive out innovation. The

Department also can restructure its management approaches, as was done in the case of the SBIRS-High program discussed earlier, to preclude excessive in-house sourcing or premature narrowing of technology focus. As will be discussed in the case of DD21/DDX, the Department can block teaming arrangements in order to prevent combinations that would result in single sources and thereby restrict the competitive pressures that drive innovation. The Department can, and does, use these tools to ensure program management decisions do not lead to unintended consequences.

The Department also uses interagency processes to influence competition and innovation while protecting national security. Using the deliberative process established by the Hart-Scott-Rodino Antitrust Improvement Act, the Department works with the Department of Justice (DoJ) and Federal Trade Commission (FTC) to block proposed business combinations when necessary to preserve competition or for other reasons of national security. The Exon-Florio Amendment to the Omnibus Trade and Competitiveness Act authorizes the President to suspend or block foreign acquisitions, mergers, or takeovers of firms located in the United States when they pose credible threats to national security by transferring key industrial capabilities. The Department participates in an interagency committee, chaired by the Department of the Treasury to exercise the Department's leadership prerogative. Similarly, the Department of Defense works with the Department of State on export controls. Export controls should be structured to keep key, critical military technology from our adversaries, yet allow domestic firms to compete in international markets to preserve their global competitiveness.[7] Foreign Cooperative Agreements are agreements between the Department of Defense and foreign governments that allow the Department to develop and access foreign technologies and products that offer unique warfighting benefits.

<u>DoD Measures</u>

The Department has various corrective measures it can apply in order to preserve a robust, innovative industrial base when such action is necessary. First of all, it can take measures to induce innovation by staging competitions to add sources. Over the years, the Department sometimes has been forced to induce innovation within high risk programs or programs that have shown a decline in performance. Techniques range from developing alternative sources, such as in the case of the Navy's ARCI program, to developing technology insertion processes such as practiced today with spiral development planning.

[7] Northrop Grumman's development of the APG-68(V)9 radar for sale to the United Arab Emirates and Singapore helped bring forward technologies and mitigate risk on 4th generation radars for both the F-22 and JSF programs. The foreign investment helped to lower non-recurring engineering costs and to transfer technology and manufacturing advances to production. This demonstrates how "the international market" benefits the Department.

The goal always has been to find the best technology and ideas so that program offices can source the broadest array of solutions available.

Another measure the Department sometimes employs is to restructure its management approach. As was discussed earlier, when the SBIRS-High program was experiencing significant problems in late 2001, the Department took action to restructure management oversight to ensure the maturation of innovative technologies inherent in the program, among other corrective measures. The formation of joint program offices within the Department is often used to create a management structure to accelerate the development of innovation and the preservation of competitive sources. Examples of this are the Missile Defense Agency and the recent stand-up of the Joint Unmanned Combat Air Systems program office at DARPA.

A third measure that the Department occasionally employs is to block teaming arrangements. Teaming relationships sometimes can effectively reduce the number of suppliers in a given market, especially if the two firms teaming are dominant in a particular market sector. On some occasions, it becomes necessary for the Department to interject itself to avoid, or even break up, teaming arrangements between companies in order to sustain competitive conditions and nurture innovation.

DDX EXAMPLE

- Industry teaming threatened access to innovation
- Acquisition strategy revised to ensure competitive sources

One notable example of the Department wielding the *employ external measures* lever occurred in 1998, when the two existing Navy combatant shipbuilders, Ingalls and Bath Iron Works, and the Navy's only large ship combat system supplier/integrator, Lockheed-Martin, announced they would team to bid for the Navy's new DD21 surface combatant ship design and construction program. To motivate continued improvement in key industrial capabilities, the Navy developed and implemented a revised acquisition strategy prohibiting Ingalls/Bath Iron Works and Lockheed-Martin from participating as a team. Thus, for the DDX competition, the two shipyards formed separate teams, promoting the development of distinctive capabilities and alternative sources in a critical industrial sector.

Interagency Measures

There are also measures the Department can employ in collaboration with government regulatory bodies outside the Department. The Hart-Scott-Rodino (H-S-R) legislation provides the basis for the Department's review of the impact of proposed acquisitions or mergers on innovation and competition in the industrial base. Working closely with anti-trust authorities, the DoJ and the FTC, the Department is able to block mergers or, if necessary, secure judgments that force restrictions on the acquiring firm in order to preserve competition in key

technologies for critical capabilities. Finally, the Department, in conjunction with the Department of Treasury and the Department of State, can prevent the transfer of critical technologies through Exon-Florio remedies and export control laws, respectively. On the other hand, DoD can also negotiate Foreign Cooperative Agreements to fund and access critical technologies, especially where the source for a critical capability is foreign.

H-S-R Adjudication

The Department's role in Hart-Scott-Rodino (H-S-R) assessments is to look at the implications of a transaction on future competition and innovation. This prospective look is particularly critical as revisiting a merger after the fact is only permitted if the offending issue was not foreseeable at the time of the review.

Raytheon's recent acquisition of Solypsis highlights a situation in which the Department proactively worked with the DoJ to preserve competition in technologies critical to its network-centric warfighting plans. The Cooperative Engagement Capability (CEC) will integrate battle force combat systems and sensors into a single, force-wide, distributed combat system in order to counter increasingly capable and less detectable cruise and tactical ballistic missiles.

RAYTHEON – SOLIPSYS EXAMPLE

- Proposed merger of two sensor netting companies
- Transaction allowed with agreement to offer capability to competitors
- Remedy preserved competition for future while enhancing the development of advanced capabilities

Recently, as the CEC Block II competition moved forward, Raytheon decided to acquire Solipsys, a firm with the only other sensor netting product thought to be technically mature enough to represent a viable alternative to the unique CEC hardware and software design: the Tactical Component Network (TCN). Recognizing the implications of this transaction, the Department used the *employ external measures* lever and, with the DoJ, insisted that Raytheon sign a letter of agreement to offer the Solipsys TCN as a merchant supplier to other contractors for future solicitations. By exercising this lever, the Department preserved the possibility of competition for future defense applications. As the example illustrates, the Department works with the antitrust regulatory agencies on a forward-looking basis to ensure a healthy, competitive industrial base for critical capabilities and applications.

LOCKHEED - NORTHROP EXAMPLE

- Proposed merger of two AEW radar providers and platform integrators
- Transaction denied
- Preserved competition in AESA market

The Department also recommended antitrust regulatory actions to preserve innovation and competition in airborne active electronically scanned array (AESA) radar technologies critical to battlespace awareness. One of the defining moments for the airborne AESA industry occurred as a result of Lockheed Martin's attempt to buy Northrop Grumman in 1997. The Department and the DoJ reviewed the merger and filed suit to block it in March 1998, citing potential horizontal and vertical integration issues regarding airborne early warning (AEW) radar along with the loss of competition and innovation in a number of critical systems and components. At the time of the merger, Lockheed and Northrop Grumman were the only two U.S. AEW radar providers. Only two companies (Raytheon and Northrop Grumman) had experience integrating AESA fire control radars in fighter aircraft. After the merger, Lockheed Martin would have had significant vertical AEW and AESA capabilities and could have foreclosed opportunities to potential radar competitors or denied radars to other aircraft competitors. By blocking the merger, the Department and the DoJ preserved competition in the airborne AESA industry, paving the way for its innovation and application to myriad non-airborne applications.

NORTHROP – TRW EXAMPLE

- Proposed merger of satellite prime and subsystem provider
- Transaction allowed with consent decree providing for systems prime impartiality and requirement to provide payloads to competitors
- Department's Compliance Officer to oversee make/buy and merchant supplier provisions
- Remedies preserve competition; competitors not foreclosed from legacy TRW payloads and components

With Northrop Grumman's acquisition of TRW, the Department also took measures to ensure multiple competitive sources in the critical reconnaissance satellite systems sector. After thorough analyses of the effects of the proposed acquisition, the Department communicated its concerns to the DoJ which in turn negotiated a consent decree, forcing Northrop Grumman to select payloads on a competitive and non-discriminatory basis and to provide legacy TRW technology to other competitors.

"By requiring Northrop to make its sophisticated satellite payloads available to competitors, along with other provisions, this consent decree enables the U.S. government—the only customer of reconnaissance satellites—to continue to benefit from competitive prices, higher quality, and continued innovation."

– R. Hewitt Pate, Acting Assistant Attorney General, Antitrust Division, DoJ, December 11, 2002

Although discussed earlier as a measure the Department can use internally, blocking teaming relationships also is an action that the Department sometimes takes in conjunction with the DoJ when such teamings have the potential to adversely affect competition and thus negatively impact innovation.

The teaming relationship between DRS Technologies and Raytheon for electro-optical systems using second generation forward looking infrared technology is illustrative of a situation that required the attention of the Department and the DoJ. The Department decided to allow teaming on current contracts since the benefits of competition had already been garnered, given the phase of development of the related acquisition programs. However, the Department indicated that teaming for future programs (e.g., the Advanced Amphibious Assault Vehicle) would be unacceptable because of the negative effect on competition. The regulatory review resulted in both firms modifying their teaming agreement accordingly.

DRS - RAYTHEON EXAMPLE

- Proposed team of the only two second generation FLIR suppliers
- Teaming allowed for existing contracts; not for future competitions
- Modification of teaming agreement retains competition for future while realizing savings on current contracts

When corporate mergers or teaming agreements significantly reduce the competitive pressures which drive innovation, the Department must be prepared to use regulatory powers. In such situations, H-S-R adjudications provide the Department a means to maintain competition and induce innovation for industrial and technological capabilities critical to the warfighter.

Exon-Florio Remedies, Export Control, and Foreign Cooperative Agreements.

The Exon-Florio Amendment to the Omnibus Trade and Competitiveness Act of 1988 amended the Defense Production Act to authorize the President to suspend or block foreign acquisitions, mergers, or takeovers of U.S. firms when credible threats to national security cannot be resolved through other provisions of law. The President has delegated management of the Exon-Florio Amendment to the interagency Committee on Foreign Investment in the United States (CFIUS), chaired by the Department of the Treasury. Within the CFIUS, the Department of Defense determines if the company or business unit being acquired possesses critical defense technology under development or is otherwise important to the defense industrial and technology base.[8]

Critical technologies and capabilities highlighted by the DIBCS will be important decision aids for the Department in this process. In cases where the Department believes the technologies and capabilities are leading-edge and unavailable to potential adversaries, it may choose not to allow companies with these capabilities to be acquired by foreign companies, or it may develop remedies to reduce the risks of unauthorized technology transfer. In this manner, the Department actively works to safeguard critical defense technologies.

The Department also can advocate export control restrictions to the Department of State when U.S. companies desire to export critical technologies or

[8] For further information on the HSR and CFIUS processes, refer to the ODUSD(IP) *Business Combinations Deskbook* posted at http://www.acq.osd.mil/ip.

capabilities abroad. Conversely, where a sole source of a critical capability may be foreign, it may be advisable to engage in cooperative agreements with the company's government to ensure adequate funding to shape the endeavor.

CATALYST II EXAMPLE

- Combined U.K. and U.S. EW systems with U.K. software
- Saved $5-8 million and 2-3 years development time and increased commonality with major ally

In the case of the Catalyst II program, the Department sought more robust electronic warfare (EW) capabilities through the integration of a United Kingdom system, Soothsayer, with a U.S. system, Prophet. Each is an EW system focusing on upgrades to electronic support, electronic attack, and precision location systems. For this new application, the United States also acquired SAGE software from the United Kingdom with a state-of-the-art capability to detect, classify, and locate modern battlefield communications signals. The combined Catalyst II program saved between $5-8 million and two to three years of development time.

In summary, the portals and levers approach is a valuable tool to enhance the health of the defense industrial base. Portals encourage systematic examination of management decisions throughout the technology and program life cycles. Levers provide the means to ensure the innovation and investment that will keep the United States ahead of foreign competition for critical industrial base capabilities. Along with the levers available to programs, external measures within the Department and with the cooperation of regulatory agencies are available to retain innovation and remedy deficiencies. The Department must lead by example in applying new functional capability-based thinking, management practices, and behavior.

APPENDIX E

PROGRAM MANAGER'S FUNCTIONAL CAPABILITY CONFERENCE (PMFCC)/ CAPABILITY AREA REVIEW (CAR)

(This page intentionally left blank.)

TRANSFORMING DEPARTMENT DECISION-MAKING: CAPABILITIES-BASED PROCESSES

An integrated, capabilities-based approach to the acquisition process will drive changes in Department decision-making and corporate processes, in addition to challenging program managers to function in a capabilities context. By making decisions across functional and operational capability areas, program tradeoffs will be synchronized and prioritized with an increased understanding of relationships among programs by the broader acquisition community. These changes in acquisition oversight processes are at least as important as assuring that program managers' acquisition strategies and management techniques impart the functional capabilities context to individual programs.

Progress To Date

As the Department moves its requirements and acquisition oversight processes toward a capabilities-based paradigm, changes in the current defense program oversight process are anticipated. As shown below, USD(AT&L) has three

HOW AT&L GOALS[1] SYNCHRONIZE WITH SENIOR DEPARTMENT STRATEGY GUIDANCE AND THE 3170[2] CONSTRUCT

AT&L Goal One, Three, and Six deliverables provide complementary elements of end-to-end Department processes to implement JCIDS in Department acquisition oversight processes, system engineering, and industrial base assessments.

<table>
<tr><th></th><th>Goal One
Lead: Defense Procurement & Acquisition Policy</th><th>Goal Three
Lead: Defense Systems</th><th>Goal Six
Lead: Industrial Policy</th></tr>
<tr><td>Objectives</td><td>1. Bring Joint Capabilities perspective to acquisition
2. Increase accuracy and credibility of cost estimates
3. Shorten acquisition cycle time</td><td>1. Develop systems views of integrated architectures
2. Develop integrated plans and/or roadmaps
3. Establish broader mission context for DAB reviews
4. Foster interoperability, jointness, and coalition capabilities …</td><td>1. Capabilities-based approach to evaluate industrial base sufficiency
2. Organizational cross-feed mechanisms for IB assessments
3. Smart IB management by PMs
4. Help emerging defense suppliers bring value & innovation to DoD</td></tr>
<tr><td>Status</td><td>✓ DAES review in JFC context
✓ Prototype of Program Manager Functional Capability Conference (PMFCC) conducted June 2004
• Proof of concept PMFCC/CAR planned for Spring 2005</td><td>• Roadmap, investment strategies, and architectures in process for mission areas to support ACARs</td><td>• 5-part DIBCS study series underway in JFC context
• Until Department processes and organizations reflect JFC paradigm, companies will continue to sub-optimize on current customer-facing investment strategies</td></tr>
<tr><td>Deliverables</td><td><table><tr><th>JFC</th><th>PMFCC</th><th>CAR</th></tr><tr><td>C2/NCO</td><td>Mar 05</td><td>Apr 05</td></tr><tr><td>Force App</td><td>Apr 05</td><td>May 05</td></tr><tr><td>Protection</td><td>May 05</td><td>Jun 05</td></tr><tr><td>FocLog</td><td>Jun 05</td><td>Jul 05</td></tr><tr><td>Battl Awar</td><td>Jul 05</td><td>Aug 05</td></tr></table>In context of JFC and available roadmaps</td><td>✓ AMD roadmap and CAR DAB in May 2004
✓ Land Attack Weapons CAR DAB in May 2004
✓ JBMC2 CAR DAB in August 2004
• EW roadmap and CAR DAB planned for Nov 2004</td><td><table><tr><th>DIBCS Report</th><th>Publication Date</th></tr><tr><td>✓ Battlespace Awareness</td><td>January 2004</td></tr><tr><td>✓ Command & Control</td><td>June 2004</td></tr><tr><td>✓ Force Application</td><td>October 2004</td></tr><tr><td>Protection</td><td>December 2004</td></tr><tr><td>Focused Logistics</td><td>May 2005</td></tr></table>Other IB/Process enhancements:
• Industrial Base Investment Fund
• Shipbuilding Industrial Base Investment Fund</td></tr>
<tr><td>Periodicity</td><td>• Annual JFC CAR
• Other Department-level reviews as required
• Cost/schedule/milestone reviews at Service level to maximum extent possible</td><td>Continuous/ongoing</td><td>• Initial DIBCS series: Jan 04-May 05
• Less pressing critical technology industrial base assessments as required
• Complete update envisioned 2007-08</td></tr>
<tr><td></td><td colspan="3">← → Crossfeeds ← →</td></tr>
</table>

Source: ODUSD(IP)

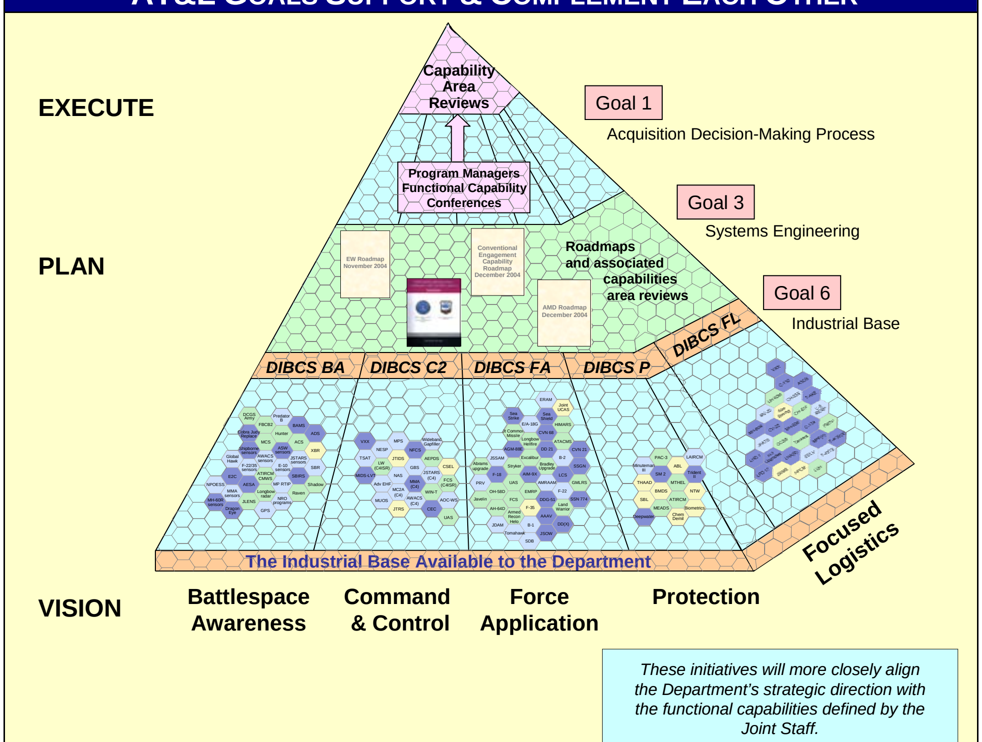
[1] USD(AT&L) chartered six goals to be worked by his senior staff during the Airlie House Off-Site in June 2003. Goals One, Three, and Six relate to acquisition process and industrial base concerns.

specific goals being worked by senior leadership teams. The goals provide complementary elements that align DoD's acquisition oversight processes, systems engineering, and industrial base assessments with the Joint Capabilities Integration and Development System (JCIDS) and the Secretary's imperative with regard to this capabilities context.

These three goal teams are working collaboratively to provide the foundation required for senior Department acquisition officials to make acquisition oversight decisions in a capabilities context. The Goal One team, chartered to bring a joint capabilities perspective to acquisition, is examining concepts that would scale current DAB reviews beyond single-program and mission capability area reviews to the larger joint functional concepts. The Goal Three team is providing the systems views, roadmaps, and integrated architectures in broader mission contexts that are building blocks for joint functional capability acquisition reviews. These initiatives in combination will foster interoperability, jointness, and coalition capabilities. Finally, the Goal Six team is applying this capabilities-based approach to industrial base assessments—and in so doing, is promulgating this capabilities-based vernacular from the warfighting community to the industrial base and its long-range investment and planning processes.

As shown below, if the industrial base is to effectively deliver the capabilities envisioned, all Department decision processes should be in the same functional

AT&L GOALS SUPPORT & COMPLEMENT EACH OTHER



Source: ODUSD(IP)

---

[2] Chairman of the Joint Chiefs of Staff Instruction 3170.01D, *Joint Capabilities Integration and Development System*, March 12, 2004.

capability vernacular. The proposed Program Manager Functional Capability Conference (PMFCC)/Capability Area Review (CAR) process, being examined by the Goal One team for implementation in 2005, is intended to accomplish this in concert with other Department initiatives and process changes.

The graphic opposite depicts how the DIBCS series has begun this synchronization by mapping warfighter capabilities to the supporting industrial base, enabling industry to establish better links to the warfighter. Armed with these studies, companies should be able to craft more effective business and investment strategies to serve DoD's warfighting goals, better communicate those strategies to the Department and other suppliers, and become important enablers of a networked, functional capability approach to modern warfighting. Companies early to market in this functional context will have substantial competitive advantages. Major defense companies already are reorganizing to respond. As companies improve their fluency in the functional-capabilities language, their ability to shape the DoD's imagination—and requirements—will improve. They will be better positioned to alert DoD program managers to technology and industrial capability connections among disparate defense programs, and better able to connect the dots on technologies with multiple applications than would an individual program manager.

> *"The functional-capability approach substantially broadens the opportunities available to industry well beyond individual programs or an individual military service. At the same time, the clear statement of this [capabilities] vision to industry should boost the flow of ideas and innovation into the department, creating a rich dialogue between industry and warfighter."*
>
> - *Suzanne D. Patrick, Deputy Under Secretary of Defense for Industrial Policy*
>   *Defense News—August 30, 2004*

The roadmaps and architectures that are part of Goal Three will inform precepts for the new CARs scaled to the joint functional concepts. They will, in aggregate, help determine the array of programs reviewed. These roadmaps to date have resulted in a series of targeted capability area reviews—Integrated Air and Missile Defense; Joint Battle Management Command and Control; and Land Attack Weapons.

The New Capability Area Review Process Envisioned

The PMFCC/CAR initiatives planned for 2005 will leverage the lessons learned from these targeted capability area reviews in order to put senior Department decisions in an even broader context, more closely aligned to the functional capabilities defined by the Joint Staff.

A preparatory PMFCC would be held several weeks prior to the CAR to map selected acquisition programs to the Joint Staff's Joint Functional Concept (JFCs) and understand the interrelationships between the programs. During the PMFCC, program managers would decompose their programs by the JFC functional capability areas and measure their program capabilities against the defined JFC attributes. In an exercise setting, the PMFCC will simultaneously evaluate multiple programs against their contribution to accomplish JFC capabilities, thereby identifying potential issues to be addressed at the CAR. The intervening time prior to the CAR will be used to validate and further investigate the issues identified at the PMFCC. These assessments will synchronize programs' ability to jointly enable the JFC. Associated decisions will optimize programmatic and budgetary resources for these programs. In turn, these required decisions would provide the basis for the Acquisition Decision Memorandum (ADM), prepared in advance of the CAR. It would then be validated during the CAR—and issued subsequently as programmatic and budgetary direction. DABs would remain program-specific reviews, delegated to the Services wherever practicable.

THE PMFCC/CAR

Process	Description
PMFCC	A preparatory conference to identify Department-level acquisition decisions by assessing programs in a capability context. During the intervening period between the PMFCC and CAR, issue working groups will validate and prioritize issues; explore options; and formulate recommendations.
CAR	A high level review body which makes the necessary decisions to improve program execution in a warfighter capabilities context. The CAR would assess synchronization, synergies, disconnects, and other issues across a large number of programs. DABs would remain program-specific reviews, delegated to the Services wherever practicable.

Source: ODUSD(IP)

DEPARTMENT PROCESSES THAT INFORM PMFCC/CAR

Process	Description
JOpsC	JOpsC is a unifying framework for developing subordinate concepts and capabilities. It lays out a strategic view of how the future Joint Force will operate and the overarching attributes with which to measure it.
JOCs	JOCs focus on the operational-level and describe how a Joint Force Commander will plan, prepare, deploy, employ, and sustain a joint force given a specific operation or campaign.
JICs	JICs are a further refinement of concepts focused on a specific class of operational missions or threads.

Source: ODUSD(IP)

A multitude of existing Department processes, some of which are summarized in the chart above, will inform the envisioned PMFCC/CAR process and tie to the Department's strategic planning. The Joint Operations Concepts (JOpsC) provide an operational context for the CAR process based on the JFC description of functional capability areas and attributes. The four Joint Operating Concepts

(JOCs) (i.e., Major Combat Operations, Stability Operations, Homeland Security, and Strategic Deterrence) articulate how the future force will operate within specific segments of the range of military operations. The Joint Integrating Concepts (JICs) (e.g., Joint Forcible Entry Operations, Undersea Superiority, Seabasing) describe critical tasks and associated capabilities needed to support specific missions—i.e., how a Joint Force Commander 10-20 years in the future will integrate capabilities to generate effects and achieve an objective. JICs have the narrowest focus of this family of concepts, and distill JOC and JFC-derived capabilities into fundamental tasks, conditions, and standards, enhancing the foundation required to conduct a CAR assessment.

The envisioned CARs would make decisions to optimize programs' collective ability to provide the functional capabilities required for 21st century warfare. In these high order reviews, the Department would assess synchronization, synergies, disconnects, and other issues across a large number of programs. The ensuing programmatic and budgetary decisions would be documented in an ADM for each functional CAR. As a body of decisions, these ADMs would represent annual, synchronized, and funded capabilities oversight. They would also document oversight guidance responding to—and informing—Strategic Planning Guidance, Joint Programming Guidance, and Functional Capability Boards (FCBs).

"If programs were arrayed [across operational effects-based sectors], emerging defense suppliers would be able to ascertain opportunities that cut across individual programs and platforms… Conversely, senior DoD leaders would be better positioned to identify technology 'gaps' affecting both individual and multiple programs."

- "Transforming the Defense Industrial Base: A Roadmap," February 2003

As envisioned, these CARs would be held annually for each of the functional concepts that are directly tied to materiel solutions. In effect, the CARs would continue the process change accomplished by FCBs: programs initiated in functional contexts would be consistently monitored and re-synchronized to these contexts. We learned from our taxonomy work that programs are never static. Hence it is important to continually assure that all programs enabling given functional capabilities remain synchronized to these capability goals—and able to adapt to functional capability changes. An integrated, capabilities-based approach to program acquisition and associated oversight processes will not only improve Department decision-making, but also offers an enterprise-level view of a much broader expanse of the programs that collectively enable the desired warfighting capabilities. With this broader view, it should be possible to more effectively—and efficiently—inject innovation across the defense enterprise using the opportunity presented by the CAR process as an annual series of portals.

(This page intentionally left blank.)

APPENDIX F

TECHNOLOGY READINESS LEVELS (TRLS)

(This page intentionally left blank.)

Overview of Technology Readiness Levels

DoD 5000.2-R establishes technology maturity expressed in Technology Readiness Levels (TRLs).[1] It is important to have a strong grasp of the TRL concept. The tables in this section give the TRL fundamentals in the form of brief descriptions, definitions, and indicators to substantiate the TRLs.

Using TRLs to describe the maturity of technologies considered for use in a new system originated with NASA in the early 1980s. The levels ran from the earliest stages of scientific investigation (level 1) to successful use in a system (level 9), which equates to space flight for NASA. DoD has adopted the NASA definitions—with only minor modifications—for the nine TRLs.

Table F-1 gives the DoD TRL levels, definitions, descriptions, and supporting information. It also describes typical documentation to support a TRL assignment. Table F-2 includes a set of additional definitions that help provide for the uniform interpretation of the levels. The DoD TRL levels, definitions, and descriptions in Table F-1 and the set of additional definitions in Table F-2 have been extracted from DoD 5000.2-R, dated April 5, 2002.[2]

Table F-1. TRL Definitions, Descriptions, and Supporting Information

TRL	Definition	Description	Supporting Information
1	Basic principles observed and reported	Lowest level of technology readiness. Scientific research begins to be translated into applied research and development. Examples might include paper studies of a technology's basic properties.	Published research that identifies the principles that underlie this technology. References to who, where, when.
2	Technology concept and/or application formulated	Invention begins. Once basic principles are observed, practical applications can be invented. Applications are speculative, and there may be no proof or detailed analysis to support the assumptions. Examples are limited to analytic studies.	Publications or other references that outline the application being considered and that provide analysis to support the concept.
3	Analytical and experimental critical	Active research and development is initiated. This includes	Results of laboratory tests performed to measure

[1] TRLs are the centerpiece for the Technology Readiness Assessments (TRAs) required for ACAT ID and IAM programs. Other means to accomplish a TRA are allowed but only when approved in advance by the Department. Willoughby charts are a possible alternative. No alternatives to the TRL-based process have been approved thus far. DUSD(S&T) is responsible for TRL guidance for the Department.

[2] Software is likely to be an important element in many TRAs. Since the TRL definitions in Table F-1 reflect a systems approach in which software is treated as a part of a component or system, software TRLs are not spelled out specifically in these definitions.

	function and/or characteristic proof of concept	analytical studies and laboratory studies to physically validate analytical predictions of separate elements of the technology. Examples include components that are not yet integrated or representative.	parameters of interest and comparison to analytical predictions for critical subsystems. References to who, where, and when these tests and comparisons were performed.
4	Component and/or breadboard validation in laboratory environment	Basic technological components are integrated to establish that they will work together. This is relatively "low fidelity" compared to the eventual system. Examples include integration of "ad hoc" hardware in the laboratory.	System concepts that have been considered and results from testing laboratory-scale breadboard(s). References to who did this work and when. Provide an estimate of how breadboard hardware and test results differ from the expected system goals.
5	Component and/or breadboard validation in relevant environment	Fidelity of breadboard technology increases significantly. The basic technological components are integrated with reasonably realistic supporting elements so they can be tested in a simulated environment. Examples include "high-fidelity" laboratory integration of components.	Results from testing a laboratory breadboard system are integrated with other supporting elements in a simulated operational environment. How does the "relevant environment" differ from the expected operational environment? How do the test results compare with expectations? What problems, if any, were encountered? Was the breadboard system refined to more nearly match expected system goals?

Table F-1. TRL Definitions, Descriptions, and Supporting Information (Continued)

TRL	Definition	Description	Supporting Information
6	System/subsystem model or prototype demonstration in a relevant environment	Representative model or prototype system, which is well beyond that of TRL 5, is tested in a relevant environment. Represents a major step up in a technology's demonstrated readiness. Examples include testing a prototype in a high-fidelity laboratory environment or in simulated operational environment.	Results from laboratory testing of a prototype system that is near the desired configuration in terms of performance, weight, and volume. How did the test environment differ from the operational environment? Who performed the tests? How did the test compare with expectations? What problems, if any, were encountered? What are/were the plans, options, or actions to resolve problems encountered before moving to the next level?
7	System prototype demonstration in an operational environment	Prototype near, or at, planned operational system. Represents a major step up from TRL 6, requiring demonstration of an actual system prototype in an operational environment such as an aircraft, vehicle, or space. Examples include testing the prototype in a test bed aircraft.	Results from testing a prototype system in an operational environment. Who performed the tests? How did the test compare to expectations? What problems, if any, were encountered? What are/were the plans, options, or actions to resolve problems encountered before moving to the next level?
8	Actual system completed and qualified through test and demonstration	Technology has been proven to work in its final form and under expected conditions. In almost all cases, this TRL represents the end of true system development. Examples include developmental test and evaluation of the system in its intended weapon system to determine if it meets design specifications.	Results of testing the system in its final configuration under the expected range of environmental conditions in which it will be expected to operate. Assessment of whether it will meet its operational requirements. What problems, if any, were encountered? What are/were the plans, options, or actions to resolve problems encountered before finalizing the design?
9	Actual system proven through successful mission operations	Actual application of the technology in its final form and under mission conditions, such as those encountered in operational test and evaluation. Examples include using the system under operational mission conditions.	Operational Test and Evaluation reports.

Table F-2. Additional Definitions of TRL Descriptive Terms

Term	Definition
Breadboard	Integrated components that provide a representation of a system/subsystem and which can be used to determine concept feasibility and to develop technical data. Typically configured for laboratory use to demonstrate the technical principles of immediate interest. May resemble final system/subsystem in function only.
High Fidelity	Addresses form, fit, and function. High-fidelity laboratory environment would involve testing with equipment that can simulate and validate all system specifications within a laboratory setting..
Low Fidelity	A representative of the component or system that has limited ability to provide anything but first order information about the end product. Low-fidelity assessments are used to provide trend analysis.
Model	A functional form of a system, generally reduced in scale, near or at operational specification. Models will be sufficiently hardened to allow demonstration of the technical and operational capabilities required of the final system.
Operational Environment	Environment that addresses all of the operational requirements and specifications required of the final system to include platform/packaging.
Prototype	A physical or virtual model used to evaluate the technical or manufacturing feasibility or military utility of a particular technology or process, concept, end item, or system.
Relevant Environment	Testing environment that simulates the key aspects of the operational environment.
Simulated Operational Environment	Either (1) a real environment that can simulate all of the operational requirements and specifications required of the final system or (2) a simulated environment that allows for testing of a virtual prototype; used in either case to determine whether a developmental system meets the operational requirements and specifications of the final system.

APPENDIX G

INDUSTRIAL BASE INVESTMENT FUND APPLICATION FORM

(This page intentionally left blank.)

Defense Industrial Base Investment Fund Application Form

Instructions to applicants. Complete all fields as completely as possible. Submit separate forms for each product/technology. For items 3-6, choose appropriate selection from pull down menus. To make most effective use of this application, it is important to be very familiar with the Defense Industrial Capabilities Studies (DIBCS) which maps discrete enabling technologies to warfighting capabilities within broad functional concepts. Accurate technology/product positioning within this construct is critical for proper assessment, evaluation and screening. For items 4-6, refer to the appropriate DIBCS report appendix for definitions. Submissions are treated as applicant-proprietary by the Department of Defense. Submission assumes endorsement of Chief Technology Officer and Chief Executive Officer.

1 Organization Name/Location:	***2 Organization Type:***
Include name of holding company/parent organization if applicable. City, state and country of headquarters and operating location responsible for technology/product (if different)	*Public or private Company, non-profit institution, academic or federal lab, FFRDC, other.*
3 Organization Description:	***4 Functional Capability:***
Provide description of your firm/organization to include treatment of your size, experience and capability, generally, and specifically as it pertains to your submission.	*Must be one of five Joint Staff/DIBCS defined functional architectures to which proposal applies (Battlespace Awareness, Command & Control, Force Application, Protection, or Focused Logistics)*
5 Technology Area:	***6 Warfighting Capability:***
Specific technology area which is best fit for your technology/product. Technology area selections are defined by selection in block 4. Refer to Appendix B of the corresponding DIBCS report for listing.	*Specific warfighting capability enabled by technology/product. Capability selections are defined by selection in block 5. Refer to Appendix A of the corresponding DIBCS report for listing.*
7 Total Estimated Cost:	***8 Estimated Time:***
Include full treatment of NRE and recurring costs. Provide cost analogies as appropriate to reinforce estimates.	*Provide estimate of when first product can be delivered, if applicable, when interim operational capability will occur, and on what platforms.*

9 Competitive Assessment:

Describe differences between technology/product and most immediate competitor technologies/products and the state-of-the-art. Refer to company compendium of appropriate DIBCS report for list of competitors. Treatment should not be limited to these firms. Write in complete sentences. Limit response to 300 words.

10 Technology Maturity:

Describe the maturity of the technology. Use technology readiness level (TRL) if such an assessment has been done. If not, describe degree to which the technology/product has been demonstrated and is in use, either as part of a fielded system or as a commercial product. Treat risk. Write in complete sentences. Limit response to 300 words.

11 Producibility Assessment:

Describe degree to which product/technology is being produced. Include current production volume, location of production facilities and surge capability/capacity with relative timing (i.e. how much time/investment to double production). Treat risk. Write in complete sentences. Limit response to 300 words.

12 Stakeholder Support/Validation:

Provide specific names, positions, organizations and contact information of stakeholders you've contacted with regard to this innovation, the degree and type of support received. Also include historical treatment of investment in and development of the product/technology. Write in complete sentences. Limit response to 300 words.

13 Chief Technology Officer:	***14 Chief Executive Officer:***
Enter name and contact information to include address, e-mail, phone and fax numbers. Unless otherwise indicated, it is assumed the CTO is the primary point of contact.	*Include name and contact information to include address, e-mail, phone and fax.*

(This page intentionally left blank.)